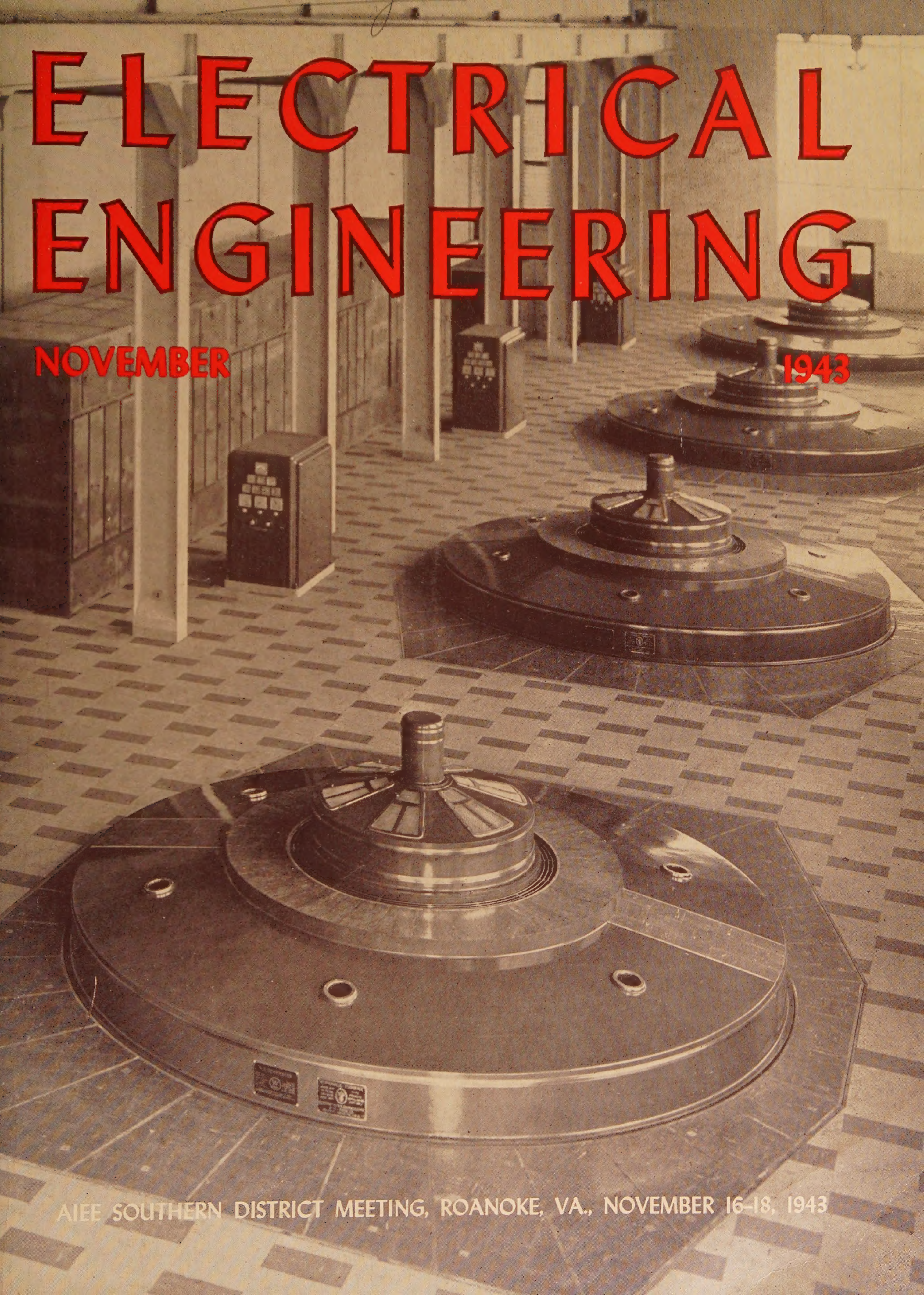
ELECTRICAL ENGINEERING

NOVEMBER 1943



AIEE SOUTHERN DISTRICT MEETING, ROANOKE, VA., NOVEMBER 16-18, 1943

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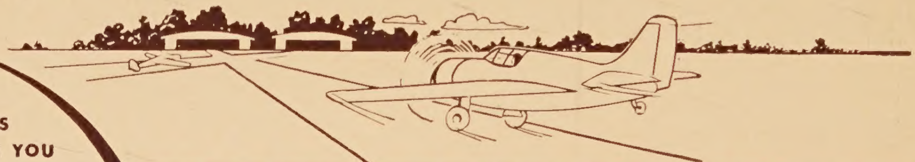

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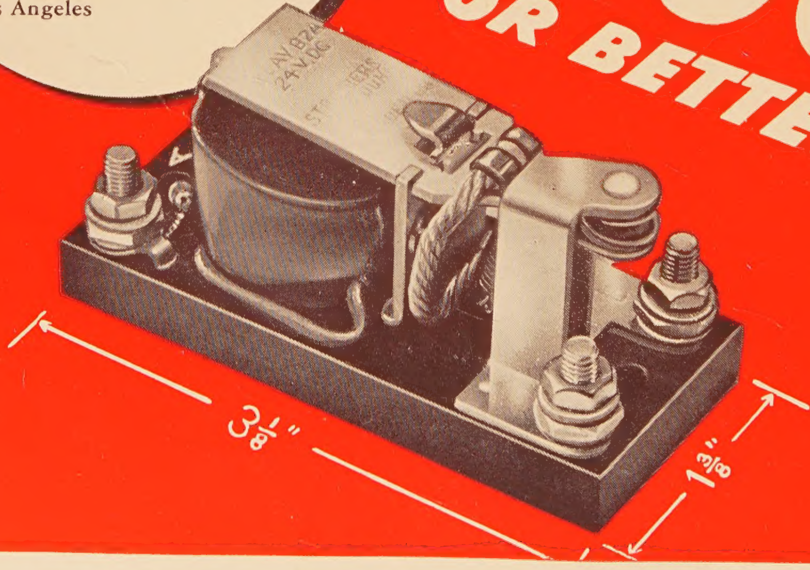

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The Cover: Interior of the generator room at Claytor Dam, Appalachian Electric Power Company, near Roanoke, Va., where the AIEE Southern District will hold a technical meeting November 16–18. Rating of each of the four units is 18,750 kva.

TRANSACTIONS SECTION

(Follows EE Page 518; a preprint of pages 667–730 of the 1943 volume)

Statements and opinions given in articles and papers appearing in *Electrical Engineering* are the expressions of contributors, for which the Institute assumes no responsibility. ¶ Correspondence is invited on all controversial matters.

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AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Founded 1884

VOLUME 62
NUMBER 11

The Rubber Plant

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The making of synthetic rubber involves among other things the exact control of gas mixtures of great complexity. Formerly the analysis of some gases required several days of painstaking laboratory work, and in some cases a complete analysis was impossible.

Westinghouse scientists—working in close collaboration with engineers of leading oil and chemical companies—have perfected an electronic "chemist" which is an important addition to the present methods of analysis.

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The starting voltage is then changed to allow the nitrogen ions to pass through the same exit slit—thus measuring the *quantity of nitrogen.* This same principle applies to the analysis of complex hydrocarbon mixtures.

The development of the mass spectrometer . . . for the quick, accurate analysis of butadiene . . . is a typical example of the way Westinghouse "know how" in electronics is tackling the wartime problems of industry in an effort to speed victory.

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Copper Mining and the Utah Copper Mine

ROBERT S. LEWIS

COPPER, without much question, was the first metal smelted by man. Used as the native metal, or else alloyed with tin to form bronze or with zinc to form brass, copper was known and utilized many thousand of years before Christ; in fact the Egyptians, before 6000 B.C., fashioned copper into sheets, knives, and harpoons. Egyptian paintings of 1500 B.C. illustrate the smelting of copper in primitive furnaces. The Romans obtained copper from the island of Cyprus in the Mediterranean Sea and called the metal "aes cyprium," a term which became transformed into "cuprum" from which the word copper is derived. A bronze head of Brutus, an example of the sculpture of the Republican period dated about the 4th century B.C., is a magnificent piece of work.

The history of copper mining is of especial interest inasmuch as copper has become one of our most strategic weapons in the winning of the war. One of the principal methods in use today is open-pit mining. The mine of the Utah Copper Company described in this article is typical of modern open-pit mines.

In the Western Hemisphere copper was mined in Chile before Pizarro conquered the Incas in 1533. However, the first Spanish mining was in 1601, and the first modern smelting in 1842. Copper was discovered in the United States in 1632, but the first mining of copper in this country was done in 1705 at the Simsbury mine in Connecticut. The Lake Superior copper region was opened in 1830. Copper mining at Ducktown, Tenn., began in 1843. Both the Butte, Mont., and the Bisbee, Ariz., districts were well known by 1874, and by 1905 the era of the large low-grade open-pit or "porphyry copper" mines began in the United States and in Chile. In 1924 sampling, by drilling, of the Northern Rhodesia copper region disclosed large deposits of unusually rich copper ores, some 150 miles to the southeast of the already known rich oxidized ores of the Katanga district in the Belgian Congo.

From early times up to 1880 copper was produced in relatively small amounts. From 1801 to 1810 the world's production of copper was but slightly over 18,000 tons, or less than one month's production of some of our present-day mines. England was the leading producer until 1850, when Chile assumed first place. In 1883 the United States became the world's leading copper producer, and it still holds that place, although its dominant position in the world's markets is steadily declining. Thus, from 1913 to 1929 the United States' production of copper rose 64 per cent, but that of all other countries increased 129 per cent.

In 1938 the world's mine and smelter production of copper was, in round numbers, 2,229,000 short tons distributed as follows:

United States	24.5 per cent	Russia	5 per cent
Chile	17 per cent	Japan	4.9 per cent
Canada	12.5 per cent	Germany	1.5 per cent
Rhodesia	12.4 per cent	Italy	0.05 per cent
Belgian Congo	6 per cent		

In several of these countries the production of copper has been greatly increased since 1938. In 1931 the British Empire produced 98,000 tons of copper and consumed about 170,000 tons. The rapid developments in mining in Canada and Northern Rhodesia increased copper production from 99,000 tons in 1925 to 685,000 tons in 1939. As a result of these developments, about 1,000,000 tons of copper were made available to the British Empire in 1940. Of this amount some 880,000 tons were shipped to England, but an unknown tonnage was sunk before it reached its destination. France, during the German invasion in June 1940, was able to reship some 83,000 tons of copper from Bordeaux to England, the United States, and French Morocco, but the Germans captured an estimated 80,000 tons at various ports, in addition to domestic stocks.

The world reserves, in short tons of metallic copper, were estimated by P. E. Barbour in the October 1934 issue of *The Engineering and Mining Journal* (see Table I).

From the standpoint of tonnage of ore, the Chuquicamata (Chile) mine of the Anaconda Copper Company leads with reserves of 1,035,000,000 tons of 2.15 per cent copper ore. The Potrerillos (Chile) mine, another Anaconda property, contains 124,000,000 tons of 1.47 per cent copper ore. The Braden Copper Company's mine in Chile contains 226,000,000 tons of 2.18 per cent copper ore. Contrast this low-grade ore with that from five Northern Rhodesia mines totaling about 500,000,000 tons of approximately 4.0 per cent copper ore. Some

Table I. World Reserves in Short Tons of Metallic Copper

Country	Tons	Per Cent
United States	20,993,000	21
Canada	5,620,000	5
Chile	35,499,000	34
Rhodesia	22,395,000	21
Belgian Congo	6,511,000	6
Russia	10,851,000	10
All others	2,961,000	3
Total	104,830,000	100

Essential substance of a paper presented at the AIEE national technical meeting, Salt Lake City, Utah, September 2–4, 1943.

Robert S. Lewis is professor of mining, University of Utah, Salt Lake City, Utah.

of these mines can produce ore for two or three years that will not fall below ten per cent copper. The rich Katanga belt, across from Rhodesia, has an estimated 40,000,000 to 80,000,000 tons of seven to eight per cent oxidized copper ore. Thus tonnage of ore alone is misleading unless the grade of ore is also stated.

In regard to Germany, Japan, and Italy, Germany produces normally about 33,000 tons of copper a year, mostly from her Mansfield mine, a bed of copper-bearing black shale only 15 inches thick and containing from two to three per cent copper. She has acquired by conquest the Bor mine in Yugoslavia that produced 64,200 tons of copper in 1938, and the Roros mine in Norway that produces about 20,000 tons of copper per year. Germany's consumption of copper averaged 237,000 tons a year for the period 1934 to 1938. During prewar years she accumulated large stocks of copper from abroad. In 1938 more than 85 per cent of her imports came from the Western Hemisphere and Africa, sources closed to her in 1940.

Japan's production of copper in 1938 was approximately 115,000 tons. Her imports in 1940 were about 146,000 tons, of which 109,600 tons came from the United States, 19,000 tons came from Chile, some 12,000 tons came from Canada, and 6,000 tons were from the Philippine Islands. A definite sign of the Axis' nations preparation for war was the growing imports of strategic minerals for several years before the beginning of hostilities. Thus Japan increased her imports of copper from 1,181 tons in 1930 to 146,000 tons in 1940. This unusual increase in imports of a strategic mineral was a clear warning of a coming war.

Italy's mines produced 335 tons of copper in 1935 and 1,000 tons in 1938, while her consumption of copper for those two years was 80,000 and 90,000 tons, respectively. The substitution of aluminum for copper in the electrical industry is expected to save about 20,000 tons of copper a year.

The United States is the only one of the world's largest consumers of copper that normally produces enough of the metal to satisfy its own requirements, thus making this country both the largest consumer and the largest producer of copper. In ordinary times the United States consumes about 80 per cent of the new copper it produces. As to the percentage distribution of copper production in the United States the figures are as follows:

Arizona	32 per cent	Nevada	9 per cent
Utah	27 per cent	New Mexico	8 per cent
Montana	14 per cent	Michigan	5 per cent

Other producing states 1 per cent or under

This figure will change a little as the Morenci mine in Arizona increases its output some 15 per cent.

Copper is characterized by its indestructibility under normal conditions of use. Hence, secondary or scrap copper is an important source of supply. In 1922 the tonnage of scrap copper thrown on the market was sufficient to bring on a closing of the primary copper producers for a period of ten months. From 1920 to 1923 more than 60 per cent of the copper sold was from scrap. In the depression of 1930 to 1935, when a strong effort was made by primary producers to curtail production, 80 per cent of our copper requirements was supplied by scrap. In this period the price of copper dropped to an all-time low of five cents per pound. This low price caused a tremendous increase in the use of copper in the building trades. In 1938 the production of secondary copper in the form of old and new scrap was about 360,000 tons or 65 per cent of the domestic-mine output.

In 1888 a Frenchman, M. Secretan, believing that the phenomenal development in the use of electricity has resulted in a demand for copper that had outstripped all capacity for production, attempted to corner the copper market. However, he miscalculated the stocks of copper in private hands and the amount of scrap that would be collected under the stimulus of high prices. He could not hold the price of copper up long enough to dispose of his huge stock at a good profit, and it took his bankers several years to market his accumulated mountain of copper.

As to the chief uses of copper in industry, they ordinarily rank as indicated in Table II. Some idea of the application of copper to war purposes may be gained from data in Table III.

Table II. Chief Uses of Copper in Industry

	Per Cent
Electrical manufactures	24.0
Manufacture for export	14.8
Wire and rods, but not power lines	12.0
Automobiles	10.3
Buildings	10.2
Total	71.3

Table III. Application of Copper to War Purposes

Item	Copper Required for Munitions
For every medium tank	998 pounds
For every 155-millimeter gun	2,839 pounds
For every *P*-40 plane	1,660 pounds
For every *P*-38 plane	2,982 pounds
For every *C*-62 cargo plane	2,850 pounds
For every battleship	2,000,000 pounds
For every scout car	150 pounds
For every 37-millimeter gun	600 pounds
For every 90-millimeter gun	1,480 pounds
For every 105-millimeter howitzer	250 pounds
For 0.30-caliber shells (per million)	13 tons
For 0.50-caliber shells (per million)	58 tons
For signal-corps wire	2,000,000 pounds per month
Total signal-corps requirements	10,000,000 pounds per month

If we examine the figures for the individual production per miner, using tons of ore per man-shift as the basis for comparison, we find a marked increase in the output of copper ore between early mining and recent mining, as shown by the data in Table IV.

The increase in output per man-shift is due to the development of improved methods of mining and the

Table IV. Output in Tons of Copper Ore Per Man-Shift

Copper industry as a whole	About 1/2 ton in 1880 and about 9 tons in 1936
For underground copper mining	About 2 tons in 1914 and 4 1/4 tons in 1936
For open-pit copper mining	About 9 tons in 1914 and 31 1/4 tons in 1936

use of better equipment and shows conclusively the advantage of open-pit mining, where this method can be used.

Though ores mined by open-pit methods are generally of lower grade than ores mined underground, the greater output per man-shift for open-pit mining results in a lower cost per pound of recoverable copper in the ore. Thus for the period 1926 to 1930 the direct mining cost only per pound of copper was 2.26 cents for open-pit mining as compared with 4.10 cents for underground block-caving methods (cheapest underground method of mining) and 4.53 cents for all underground mines.

Open-pit mining is applicable to ore bodies of large horizontal extent overlain by a capping or overburden that is not too thick, say not over 300 feet thick, although this figure varies at different mines. This capping has to be removed, and the ore is then mined in benches by power shovels. These benches vary from 25 to 50 feet in height and may be from 30 to 100 or more feet in width. They vary in number with the depth of ore, ranging from three or four to as many as 22 or even more. The benches should be so proportioned that the over-all slope of the pit is not steeper than the angle of repose of the material in the sides of the pit; else the sides would tend to slide into the pit, injuring men and equipment and delaying operations. Making the over-all slope of the pit sides much flatter than the angle of repose would insure safer operation, but the flatter the slope the greater is the yardage of overburden that eventually must be removed around the rim of the pit. Calculations are made to determine the maximum number of cubic yards of overburden that can be removed per ton of ore, and the pit slopes must be kept inside this limit if a profit is to be made from operations.

Overburden and ore must be drilled and blasted to proper size, so that the material can be handled by the power shovels. If some of the material breaks in pieces too large to be handled by the shovels, these pieces must be broken to proper size. This operation is called "secondary blasting."

Hauling ore and waste out of the mine is an important operation, and it sometimes presents a difficult problem. Millions of tons of waste or capping require a large volume of dumping space, which may be hard to find in mountainous country. The necessary long haul, in this case, may be a decided disadvantage in operations. In the pit, the railroad tracks may spiral around as they lead down to the bottom, but the grade must not be too steep. On a side hill, there must be switchbacks, preferably at each end of a level or bench, so that the trains can work their way up or down the slope.

In general, open-pit operations are affected adversely by bad weather, a heavy cost is incurred in equipping the mine, and a large capital outlay is required since much capping may have to be removed before any ore can be mined. To offset these disadvantages the large scale of operations results in a relatively low cost for labor. Operations are safer than in underground mining, and working outdoors makes for better health of workers. Flexibility of output is another important advantage, since production can be materially reduced, even to the point of shutting down, without incurring the high expense that closing an underground mine entails. Finally, the application of the flotation method of concentrating ores to the "porphyry coppers" makes it possible to secure a high recovery of the copper in these low-grade ores.

THE UTAH COPPER MINE

Location. The open-pit mine of the Utah Copper Company is situated about 30 miles southwest of Salt Lake City in the Oquirrh range of mountains. After the ore is mined, it is transported some 18 miles northward to the Magna and Arthur concentrating plants, where it is treated by the flotation process to yield molybdenum and copper concentrates. The molybdenum concentrates are shipped as a finished product, but the copper concentrates are smelted at the Garfield plant of the American Smelting and Refining Company, four miles west of the mills. The "blister copper" from the smelter, containing gold and silver and other impurities is shipped to the Baltimore refinery of the American Smelting and Refining Company, where the precious metals are recovered and the copper is converted into a purer marketable form.

History. Limitations of space do not permit presenting the interesting history of this mine in full, but the following brief chronology will give some idea of the length of time and the difficulties that were involved in promoting this first "porphyry-copper" mine, which was turned down by several engineers and financial interests, because no one had yet attempted to mine such a large deposit of such low-grade ore. In fact, some mining men said it could not be done successfully.

In July 1887, Colonel E. A. Wall visited the Bingham district and noticed indications of copper ore. He found the ground open to relocation, because showings of copper were held in low esteem at that time (gold ores and silver-bearing lead ores were desired), and during the next ten years he acquired all or part of 19 claims—some 200 acres. Eight years later Captain De Lamar acquired a six-month option on three quarters of the Wall holdings but subsequently dropped the option. In May 1899, De Lamar purchased a quarter interest for $50,000 selling it later to D. C. Jackling and associates for $125,000. On January 23, 1903, after many fruitless efforts to finance the property, Jackling obtained an option on two-thirds Wall's holdings for $350,000. Jackling then interested Charles M. MacNeil, Spencer

Penrose, and R. A. F. Penrose in the property, and on June 4, 1903, the Utah Copper Company was incorporated for $500,000 in one-dollar shares. In April 1904, the company was reorganized under the laws of New Jersey with a capital of $4,500,000 in ten-dollar shares. Finally, in March 1910, the Utah Copper Company absorbed a neighboring property, the Boston Consolidated mine, thus rounding out its holdings. Now, the Kennecott Copper Corporation is the owner of the mine and the Utah Copper Company is the operating division.

Geology. A mass of monzonite porphyry, a rock closely related to a granite but lacking in free quartz and with feldspar minerals at many points as large as crystals or groups of crystals in a mass of fine-grained crystals (porphyritic structure), was intruded into beds of quartzite thousands of feet thick and containing a few strata of limestone. As the porphyry mass cooled and solidified, it became fractured, with some large and many tiny cracks, much as you see in a crackled china dish. From the subterranean reservoir or magma, a second flow, this time of mineralizing solutions, penetrated the porphyry mass and deposited the copper minerals. Later, surface waters percolated into the top of the mass and through chemical action dissolved the copper minerals, only to redeposit the copper on original copper minerals deeper down in the mass, thus forming a secondarily enriched ore deposit.

The deposit has an over-all length northeast and southwest of about 6,000 feet, a maximum width of 4,000 feet, and a maximum thickness of about 1,500 feet. The capping or leached porphyry above the ore averaged about 115 feet in thickness, although in places it is only 20 feet thick. An analysis of the copper-bearing minerals and the amount and copper content of the minerals are given in Table V.

Very roughly the ore body is in the shape of a funnel, unusually broad at the top, the whole being distorted from a circular to an elliptical form. Bingham Canyon cuts into the porphyry mass in a roughly north and south line, leaving most of the ore to the west of the canyon, but with enough ore on the east side, in East Mountain, to make that section worth mining. This part of the mine has been opened only recently.

Vehicular Tunnel. In extending mining operations to East Mountain, it was necessary to destroy the automobile road leading up Bingham Canyon from the town of Bingham to the town of Copperfield. However, traffic had to be continued, and so it was decided to drive a vehicular tunnel under the ore in East Mountain. This is a single-lane concrete-lined tunnel 18 feet 2 inches high by 16 feet 4 inches wide with a 3-foot 10-inch elevated pedestrian lane on one side. About half of the tunnel is on a curve. Traffic is controlled by a semaphore light at each end, and no car waiting at the portal is to enter the tunnel until after the red light has turned to green. After a definite time the lights are reversed. The tunnel is 7,000 feet long and rises 450 feet on a 6.43 per cent grade.

There are three turnouts to allow for an emergency such as a flat tire or a stalled engine. An eight-blade Aerodyne fan is placed at one side of the tunnel at the upper or south portal. This fan will handle 150,000 cubic feet of air per minute and is driven by a 60-horsepower 440-volt a-c motor. The fan is controlled automatically by carbon-monoxide indicators in the tunnel. As soon as the concentration of carbon monoxide reaches 3.5 parts in 10,000 parts of air, a circuit is opened, starting the fan and closing a drop door at the upper portal. The fan remains in operation until the carbon monoxide drops to 1.5 parts in 10,000, when the circuit is closed, the drop door is raised, and the tunnel is again ready for traffic. The time of construction was 22 months, and the cost about $1,400,000.

Sampling. The first attempt to explore the ore body was by means of underground workings. Later churn and diamond drill holes were put down at various points on the surface to outline both the horizontal and vertical extent of the deposit. The results from diamond drilling were unsatisfactory, because of the discrepancy between the assays of the core and of the sludge, and so this method of sampling was discarded, and prospecting was done thereafter by means of churn drills. Light drill rigs were used for holes not more than 1,000 feet deep, and standard oil-well rigs were used for deeper holes. Holes need to be cased or lined with pipe to prevent the ground from caving into the holes. At intervals of depth, it is necessary to change to a smaller-diameter casing, because the frictional resistance of the ground against the casing makes it impossible to drive the original size of casing down to the bottom of a deep hole. When a casing becomes "frozen" or immovable, a smaller pipe is run down inside, and a smaller drill is used to continue the hole. A four-inch casing is the smallest through which a satisfactory sample can be taken (a $6^1/_4$-inch would be better); consequently a deep hole

Table V. Analysis of Copper-Bearing Minerals

Amount and Copper Content of Minerals

Mineral	Quantity as a Per Cent of All Copper Minerals	Copper Content of Mineral (Per Cent)
Chalcopyrite	80	34.5
Chalcocite	9	79.8
Covellite	7	66.4
Bornite	4	63.3

Table VI. Tons of Waste Carried by One Ton of Ore

Grade of Ore (Per Cent Copper)	Tons of Waste
0.6	0.5
0.644	1.0
0.688	1.5
0.732	2.0
0.776	2.5
0.820	3.0

is started with a large-diameter casing so that it will not be necessary to reduce the casing below four inches to attain the desired depth. One hole, 1,300 feet deep, was started with a 23-inch casing and ended with a $6^1/_4$-inch casing; the intermediate strings of casing were 20-inch, $15^1/_2$-inch, $12^1/_2$-inch, and 10-inch. A hole 1,469 feet deep required 455 days of elapsed time to drill. The average drilling rate was 3.92 feet per day, and the average progress was 3.23 feet per day. Cost of hole was $20.49 per foot.

To guard against the walls of the hole caving and affecting a sample, drilling is not carried more than 50 feet below the bottom of the casing. Samples are taken in five-foot lengths. They are recovered by a suction bailer run into the hole on a steel cable. The sludge of water and crushed ore brought up by the bailer is divided into several samples. One goes to the mine office for assay, a second goes to the mill-assay office, and a third sample is kept to be mixed with the subsequent nineteen five-foot samples to make a composite 100-foot sample as a check. This sample is assayed and also is subjected to an experimental flotation test. Holes are drilled as nearly as practicable at the apexes of equilateral triangles. The spacing of holes in material of fairly uniform value is 400 feet, but this distance is reduced to 200 feet as the limits of the ore body are approached.

Outlining the Ore Body. The first step in determining the limits or outline of the ore body is to calculate the point of cutoff, under existing conditions of costs and market price of copper. Cutoff is the lowest grade of ore that can be mined and yet pay its way. Obviously most of the ore body must be of higher grade if a profit is to be made. As a preliminary estimate, one-half a ton of waste was assumed to be moved per ton of ore, and the point of cutoff was found to be 0.6 per cent copper. Since more than one-half a ton of waste may have to be moved per ton of ore for parts of the ore body, Table VI may be set up showing the tons of waste that could be carried by ore of various grades.

By the help of this table it is possible to make drawings of various sections of the ore body. Lines are drawn upward and outward from the bottom of the deposit, and from these lines the amount of capping to be removed can be calculated. The ore body decreases in value outwardly from the main body, and the boundaries of the deposit are determined by assays rather than by any sudden geologic change from ore to valueless rock. Horses or masses of waste material are found within the ore body. Its disposition depends on its copper content. Thus, if material assayed 0.55 per cent copper and 0.6 per cent is the point of cutoff, sending this material to the mill would entail a loss of seven cents per ton as against a cost of ten cents per ton for sending it to the dump; hence it would be of advantage to send this material to the mill.

A second factor to consider is the slope of the boundary lines in relation to the angle of repose of the material. If we assume, for example, that the lines on the two opposite sides of a vertical section of the ore body slope up and out at 45 degrees to the horizontal, or on a one to one slope, it may be that the sides of a pit of this slope would not stand unsupported; that is, the angle of repose of the material might be 35 degrees. (It was as low as six to seven degrees at some points along the Panama Canal, where the material was like wet clay.) In this case the walls would slide into the pit; consequently it would be necessary to flatten the slopes to at least 35 degrees. This would mean that more capping than first calculated would have to be removed, and the enterprise might prove to be unprofitable. For these reasons, the grade of ore, amount of capping to be removed per ton of ore, and the angle of repose of the ore and capping must all be considered in outlining an ore body. Also the dip of faults, fractures, and bedding planes have an important effect on the over-all slope of pit sides.

Mining Method. Mining was started on the side of the mountain by cutting a bench along the mountain side and then putting other benches (or levels) below and above the first bench. Thus, the mountain side can be likened to a series of gigantic steps or terraces, the over-all slope from the top bench to the bottom being as low as 28 degrees at some points.

There are 23 benches or levels, beginning with *A* level as the lowest or bottom level, and passing 1,500 feet up the slope to the top. The *A* level is at elevation 6,340, the same as that of the railroad yards where trains are made up for taking ore to the mills. The ore extends downward some 1,000 feet below the *A* level, but in ever-narrowing cross section like the neck of a funnel. As benches are cut below the *A* level, they will be at 50-foot intervals and will be designated by their elevation, as 6,240, 6,190 level, and so on.

The most economical height of individual bench (or bank) is 50 feet, but some banks are higher than this. The minimum width of bench is 70 feet. The face of a single bank may be as steep as 40 degrees, but the over-all slope of the pit sides can be kept to 28 degrees by adjusting the width of the various benches. When all the ore has been removed, the excavation will be in the form of an elongated bowl some 8,000 feet long, 6,000 feet wide, and 2,500 feet deep.

Handling Waste. The stripping or capping is sent to the various dumps. The rugged topography at and around the mine makes the problem of finding sufficient dumping space for the large volume of capping an acute one. Tracks for handling waste are laid at the ends of the various levels. If the distance to a waste dump is not great, a track is run directly to the dump. However, if the dump is far away, the tracks from two levels may converge into one long waste track. At present the average length of waste haul is $2^3/_4$ miles. Waste is carried in side dump cars, of 30 or 40-cubic-yard ca-

pacity, whose dumping mechanism is operated by compressed air.

Drilling and Blasting Ore. The present method of drilling and blasting has been developed through a process of evolution. Hammer drills, driven by compressed air, are mounted on tripods and drill holes into the toe or bottom of the banks. These holes are about 25 feet deep and are bottomed a little below grade to insure breaking the ore to the desired depth. They are about 15 feet apart and are pointed from 5 to 15 degrees below the horizontal. Variations in conditions may call for changes in drilling procedure. In some cases down holes are also drilled near the top edge of the bank.

Holes are started with a bit $3^3/_4$ inches in diameter and are finished with a $1^1/_2$-inch bit. These holes are too small to hold enough powder to break the bank and must be "sprung" or enlarged by firing progressively larger charges in them until a chamber large enough to hold a full charge is made. The springing shots may consist, for example, of 7, 15, 30, and 50 sticks of low-freezing ammonia dynamite. Water is used for stemming so that the holes will not be filled with dirt. The chambered hole will take from 150 to 250 pounds of dynamite, which is loaded through a $1^1/_2$-inch pipe. The shot is fired by means of a primer consisting of one stick of dynamite with a number 6 cap connected to six feet of fuse.

Banks should be blasted well in advance of the power shovels. The material beyond the radius of operation of the shovel should not be blasted, and no loose material should be thrown onto the railroad tracks. Also, the ore should be broken so that there are few if any pieces so large that they have to be broken to smaller size (secondary blasting). After a shovel had loaded the broken ore, the banks are trimmed of loose material. Pieces likely to fall are loosened by bars, and other partly loose material is shot down by a charge of from 15 to 30 sticks of dynamite. On the average about one eighth of a pound of dynamite is used per ton of material broken.

Electric Shovels. In the early days of electrification, steam shovels were converted into electric shovels, some with a-c drive and others with d-c drive. All new shovels are now of the fully revolving type, with d-c motors and Ward-Leonard control. The motor–generator sets on these shovels take alternating current at 5,000 volts and supply the operating motors with 550-volt direct current. Each shovel receives power through 500 feet of insulated cable, which is hooked onto the power line. The cable is carried on a reel on the rear end of the shovel and permits the shovel to move about 400 feet parallel to the bank. All shovels are mounted on caterpillar treads, thus enabling them to back up quickly in case the bank threatens to slide down onto the shovel. Incidentally, the reason for limiting the height of banks to 50 feet is that this is about the maximum height for safe operation. Higher banks are too dangerous.

Shovels are provided with five-cubic-yard dippers. The loading capacity of a shovel is about 19 tons a minute, and so it would be possible to load 9,120 tons of ore in an eight-hour shift if empty cars could be supplied as fast as needed. Since cars are supplied in trains of 10 to 12 cars of 80 to 100 tons capacity each, an interval of time must elapse before a loaded train can move out, and an empty train can move up to the shovel. The loading time for a shovel is about 78 per cent of the elapsed time, and thus its actual loading rate is 7,113 tons per shift. The company has 37 shovels in all, but not all are working at the same time. Operations are on the basis of about 1,200 shovel-shifts a month.

Haulage. Fifty steam locomotives able to haul seven to ten empty cars weighing 21 tons up a four per cent grade at a speed of six to ten miles per hour were replaced by 75-ton electric locomotives ballasted to weigh 85 tons. These locomotives can pull 10 to 12 cars up a four per cent grade (the maximum grade on the switchbacks) at 12 miles per hour. This is the normal speed for a trolley voltage of 675 volts. To make them adaptable to the various conditions throughout the mine, the locomotives are provided with a main overhead pantagraph collector, two side-arm collectors, and a cable reel holding 2,000 feet of cable. Two locomotives are provided with storage batteries for running some distance beyond the end of the trolley wire.

The trolley wire is direct-suspended in the pit, and a special catenary suspension is used elsewhere. Because spreaders are used to push snow over the banks, all permanent poles are placed on the inside of the track at these places. Extra long bracket arms are used and the pull-over messenger wire is placed at the end of the arms. On bridges an *I*-beam structure, two posts, and an overhead crossbeam are used. For tracks passing over large dumps or fills a special construction is used, since the fills may settle as much as 25 feet. The trolley poles are supported on long ties, which settle with the track and maintain a fixed distance between the trolley wire and rails.

On the benches, where trolley supports have to be moved every 30 days, and where flying rocks from blasts may strike poles, the most satisfactory support was found to be portable steel towers 27 feet high, mounted on a skid base six feet long. This tower can be picked up and moved by a locomotive crane. Some structural members can be broken by flying rocks; yet the tower will still support the trolley wire. These towers also carry the three-phase 5,000-volt line supplying power to the shovels.

The speed of the locomotives is directly proportional to the voltage, and so sufficient feeder capacity is provided to prevent an excessive drop in voltage. The

feeder system is so designed that six locomotives, operating on three levels, are supplied from two sources by two feeders. Sectionalizing switches are placed at the ends of the levels so that any level can be cut off in case of line trouble.

Main-line trains to the concentrating plants are hauled by 320-ton steam locomotives of the Mallet type. The 50-car train carries 5,000 tons of ore. Trains must be braked nearly all of the 18 miles because of the 21/2 per cent downgrade; consequently the wear of brake shoes is high.

Electric Power. Power is obtained from the Utah Power and Light Company at 130,000 volts. At the Magna control station it is transformed to 44,000 volts, and a three-phase line extends to Bingham 14 miles distant. At various stations around the mine the voltage is stepped down as needed. Thus, the compressor plant requires 440 volts for its synchronous motors; 5,000 volts are used for the shovels, 2,300 volts are required for the pumps, and the 700-volt d-c current for the electric locomotives is supplied from rotary converters. About 17,000 kw are used at the mine, distributed approximately as follows:

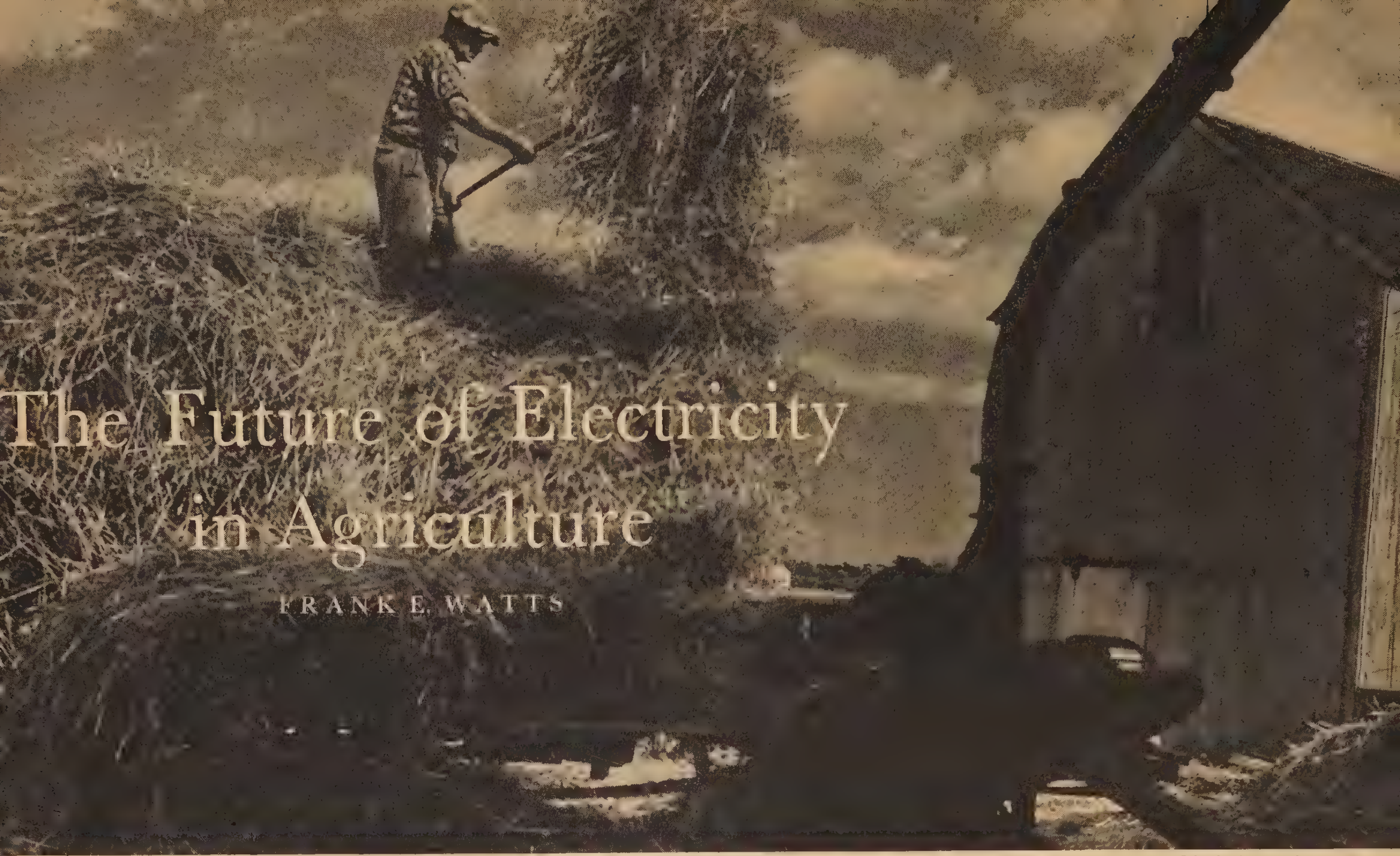
For shovels 20 per cent.
For electric haulage 47 per cent.
For compressed-air plant 16 per cent.
For shops and miscellaneous purposes 6 per cent.
For leaching and precipitation 12 per cent.

The Utah Copper Company is building a power plant that will be ready for operation in October of this year. The 50,000-kw steam turbine (coal or gas will be used as fuel) will not supply all the power needed for mine and mills, and so some 30,000 kw will still be required from the Utah Power and Light Company.

Leaching Plant. Much of the capping contains small amounts of copper chiefly in oxidized form. Ordinarily this copper would be lost when the capping is sent to the dumps. However, by pumping water onto the dumps and letting it percolate down through the capping, enough sulphuric acid is formed to dissolve the greater part of the copper. The copper-bearing solution is drawn off at the bottom of the dumps and is sent through pipes to the precipitating plant, where it passes over detinned scrap iron (waste in the manufacture of tin cans) placed in launders or long troughs. The copper is precipitated in metallic form as cement copper. Slightly more than one pound of iron scrap is required per pound of cement copper. The cement copper, in the form of a red mud, is washed out of the launders, by means of a hose, into tanks, where much of the water is drained off. The mud is loaded into cars by a crane using a clam-shell bucket, and the cars are taken to the Garfield smelter of the American Smelting and Refining Company. In this way the last possible amount of copper is recovered from the low-grade ore.

Courtesy *Mining and Metallurgy*

Bingham Canyon, Utah, cars filled with copper ore bound for smelter



The Future of Electricity in Agriculture

FRANK E. WATTS

Westinghouse photo

In postwar agricultural production electricity is destined to be a tremendous force. First postwar market for electrical appliances will be the farm, says this author, and food and agriculture will be a predominating influence in the making of the permanent peace to follow the war. The electrical industry should recognize the importance of this developing market and prepare to cope with agriculture's problems.

AN ACRE of land is to the farmer what a machine is to a manufacturer—the greater the production, the greater the return on investment. This is the basic idea today in agricultural development.

New crops and greater production of older crops per acre are making rapid strides. In the past ten years the yield of corn per acre has grown from 26.5 bushels to 35.5; of cotton, from 173 pounds to 275; of wheat from 13.1 bushels to 19.8. In 1942 the farmer produced 36 per cent more food on 22,000,000 less acres than 1932, with less man power, but more mechanical and electrical power.

On December 31, 1942, according to Edison Electric Institute statistics, 2,486,230 farms in the United States were receiving electric service from power lines. The average revenue per farm east of the 100th meridian where irrigation was no great factor was $48.07—about 30 per cent greater than that of the average urban customer. This farm revenue is pitifully small when we survey the possibilities of labor saving and increased production by applications of electricity to performing many farm jobs. A great many farms are paying from $100 to $400 annually and *making it pay*. Why then has this market not been developed further by the electrical industry? It is evident that, by and large, selling technique has not been all that it should be.

If the electrical industry is to realize potential sales in this market, it is necessary that there must be a better understanding of the farmer and modern farming. More must be known about agriculture, which after many generations is entering rapidly into a new era of development.

For many generations farming was carried on in the same pattern. Ground was plowed and tilled in much the same manner. There was some improvement in tools and implements used, but little progress was made in productive efficiency. The first and main objective was subsistence. The farmer was isolated, his work was hard, his hours were long, and his standards of living had not kept pace with those of urban dwellers.

As a result, too often his best help as well as his boys and girls left the farm for the city. Many farmers did likewise, and these were replaced by a poorer class of successors whose primary object was subsistence. Surplus depended very much upon seasonal weather and

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Essential substance of a conference paper presented at the AIEE national technical meeting, Cleveland, Ohio, September 2–4, 1943.

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management. Today the agricultural industry is undergoing a great change. Boys and girls no longer want to leave the farm. Standards of living are much higher, and the farm is a more attractive place to live. In the first World War a higher percentage of farm boys was rejected by the armed forces than any other class because of poor teeth. As a result of this discovery, dentifrices took a great upward trend in sales to farm people. Rejections of farm boys in World War II are small in comparison and are a direct reflection of higher standards of living due to enlightenment. Today a higher percentage of college and university students in relation to population come from farms than from urban centers. In the year preceding the present war, 538,000 students were enrolled in agricultural schools and colleges.

The farmer himself has become a business man. Better classes of people are being attracted to farms. As a result, agriculture is today on the highest plane it has ever attained in our history. No longer is farming looked upon as simply hard work in producing crops, but as a highly skilled profession.

The food shortage has made urban people more conscious of the farmer, his problems, and how much they are dependent upon him. This recognition is bound to bring "town and country" closer together in a greater bond of sympathetic understanding. Recruiting boys and girls to work on farms in the war emergency will also have its constructive effect in creating this understanding.

The first step to bring the farmer into closer contact with the business and industrial world was the advent of rural free delivery of mail. Then the telephone became available; then the automobile, which brought better roads, enabling him to market his products better, and keep in closer touch with his markets; and finally the radio and motion pictures. All these forces have combined to keep the farmer in close touch with a world which affects his welfare. Work of county agents and other services of the Department of Agriculture have been most constructive also, and the importance of their work is mounting at a rapid rate. Agricultural Colleges, the 4-*H* Clubs, the Future Farmers of America, the American Farm Bureau Federation, The National Grange, all are contributing to a great forward movement in agriculture.

Table I. Cost and Savings Data for a Typical Farm Electric Water System

1.	Gallons of water pumped	100,000
2.	Cost of pump and installation	$107.00
3.	Cost of electric annually (3 cents per kilowatt-hour)	$ 3.00
4.	Total cost of system and electricity for first year	$110.00
5.	Hours required to pump by hand (75 gallons per hour)	1,333
6.	Days required to pump by hand (10-hour day)	133.3
7.	Cost at $2 per day	$266.60
8.	Saving one year (over total cost of system and electricity)	$156.60
9.	Maintenance and cost of electricity after first year	$ 8.35
10.	Annual saving after first year, per year	$258.25

SCIENCE AND POWER

The forces which are bringing about an evolution almost approaching proportions of a revolution in agriculture are primarily science and power. Recognition of the possibilities of the application of these forces by enlightenment is bringing the farmer out of his isolation.

Great strides are being made in chemurgy—farm crops grown for industrial uses. Wheeler McMillen, president of The National Chemurgic Council and editor-in-chief of *Farm Journal*, said in his annual address before the council on March 24, 1943:

> "The proportion of usable wealth to be derived from an acre's production is becoming larger. From its initial concept, chemurgy has meant *maximum utilization of maximum production*. It has insisted that ways be found to use the high as well as the low values of the harvest—the stalk as well as the grain, the shell as well as the kernel, the weed as well as the crop."

At a meeting of this same council on March 27, 1942, L. F. Livingston, manager of the agricultural extension division of E. I. DuPont DeNemours and Company said:

> "Scientific research is responsible for more improvement in living conditions in the United States than any other thing. The results have benefited agriculture, industry, and consumers alike. Nearly everything we use nowadays is touched by chemistry. Living conditions are being revolutionized.
>
> "The American chemical industry has prospered in good and bad times alike, because it has had the courage to spend money to find ways of producing more and better goods for less money. A similarly constructive approach to the problems of farming will increasingly produce better varieties of grains and fruits, improved farm machinery, control of soil-borne diseases, breeding of higher-production animals, and more efficient pest-control measures that will save growers millions of dollars now being lost.
>
> "There is no limit to the factory stomach to be fed by the farm; the partnership between the farmer and the manufacturer is a close one, much closer now than most of us realize. And as we fill the arsenals in the struggle to hold our freedom, the farmer can see perhaps a quarter of a century's normal advance toward a new and more prosperous era telescoped into a few years."

Gunstocks are made from soybeans, cotton seed, and corncobs. Life preservers are made from the floss of milkweed; other substitutes for kapok are being developed from cattail fibers; plastics from cotton; from the castor bean have been developed new insecticides so badly needed; from the castor bean also is derived oil for the production of a host of critical implements of war, from tanks and bombers to cannon; rubber is now being produced from Kok-sagyz and guayule plants.

This is but a small list of new farm products used by industry. In the future, and in some instances now, crops will be grown to specifications; not just wheat, but wheat of a predetermined character; long fiber cotton is already being grown to specification. The farmer will grow not only the grains from which cereals are made, but also the products from which are made the materials for packaging such cereals. Industry and agriculture are being drawn closer together in a bond of

mutual interest, and this augers well for both. Henry Ford recently said, "The partnership of farm and industry has just begun."

AN ERA OF MECHANIZATION

As a result of these social and economic forces, the first great advance in agricultural production came with mechanization following World War I. The tractor with its related implements, its adaptability for doing by power many hard jobs more speedily and more economically has represented a great step in productive efficiency.

We must recognize that the problem of the farmer parallels that of the manufacturer in this respect. Industry by mechanization in the last generation has multiplied many times the output per man. This has resulted in greater production of more goods at less cost. The possibilities of this same productive increase are equally as great in agriculture—more goods at less cost through powered labor-saving devices. It has been said that it may be entirely possible to cut farm production costs from 25 to 50 per cent. We must recognize the depth of the forces bringing about great changes in agriculture if we are intelligently to approach the sales problem of selling the farmer. Today the great trend is toward more production per acre through scientific and power applications. Increased production per acre at less cost is the watchword of the farmer.

ELECTRICITY AS A PRODUCTIVE FORCE

In the field of power applications for productive efficiency, electricity is destined to play the leading role. No longer does the farmer want electric service primarily for its comfort and convenience, but for its great adaptability for doing jobs for labor-saving and increased production. The future will bring new applications, new devices as yet undreamed of. The electrical industry may well devote its great engineering resources to a more intensive study of the business of farming. It is only through such engineering research that we can attain the knowledge which will enable the industry to develop its great potential possibilities. We must know farm people better, we must have a greater understanding of their problems if we are to be of help in solving these problems.

Some of our large industries do not hesitate to spend a million dollars or more on research in the chemical industry, in electronics, or in plastics. Yet agriculture, representing by far the greatest investment of any industry, has been badly neglected. Agricultural income is far greater than any other—$16,138,319,000 in cash marketings in 1942. To this must be added approximately $2,000,000,000 from investments and work done off the farm and another $2,000,000,000 for food grown and consumed on the farm. This is more than seven times the income of all our electric utilities. Research work in this field has lagged probably because of the great number of farm units—over 6,000,000—whereas research in the chemical industry as an example is confined to a relatively small group. Farming will have to be broken down as to different types, and studies made of each group, depending upon the nature of crops produced or other farm operations.

While rural electrification is not by any means new, the market was more or less "spotty" and did not attract the sales and promotion activities of the industry generally until about 1936. Prior to that time, most of the promotion work was done by electric utilities. They laid the foundation for the great interest being manifested today. The impetus now apparent is such that farm people will not be denied all the comforts, conveniences, labor saving, and increased production effected by electric service. Of greatest significance is the possibility of cutting production costs through applications of electricity.

There are over 200 known uses for electricity on the farm. An analysis is made of one of the most important uses to illustrate labor savings as well as other resultant increases in production. These savings have been reduced to man-hours and dollars and cents savings estimated. These statistics, are based on actual known costs, and a sufficient degree of conservatism is applied to make the estimates safe for actual application.

ELECTRIC WATER SYSTEM

The first and one of the greatest labor savers is a water system. The example given in Table I is for a definite unit of gallonage pumped and may be reduced or expanded in relation to needs. Cost of the system, depreciation, and cost of operation are shown. The latter is based upon actual installation, the cost of which has been determined.

This direct saving in dollars does not reflect by any means all the benefits of an electric water system. Milk production is increased from 10 to 24 per cent. Cows need plenty of water—about 25 gallons per day—at frequent intervals, and drinking fountains provide this water at proper temperatures. Cows will not drink sufficient cold water for maximum milk production.

Two actual cases of increased production are here cited. The first consisted of a herd of 23 Jersey cows. For the first six months prior to installation of a water system 12,511 pounds of milk were produced. In the six-month period after the installation 15,628 pounds were produced—an increase of 3,117 pounds or 24 per cent. In the same instance, there was an average increase of 17.7 pounds of butter fat per cow.

In the second case, 15,634 pounds of milk and 507 pounds of butter fat were produced in the 30-day period preceding the water-system installation. The 30-day period following showed a production of 19,995 pounds of milk and 686 pounds of butter fat. This increase was maintained in the months following and represented an increase of 28 per cent in milk and 35 per cent in butter

fat. This meant an increase of over $1,550 in revenue annually, provided the same number of cows milked monthly is maintained. This does not consider revenue from increased butter fat. The figures seem so fantastic as to be almost incredible.

This saving in the dairy does not by any means reflect all labor or production savings. Equally impressive data may be shown for the poultry house, the barn, the home, for vegetable gardens, and many other applications. The data given are sufficient, however, to emphasize the possibilities.

"THE PROOF OF THE PUDDING"

One of the most complete records that has been kept in determining operational costs of electricity for farm jobs was that of Niagara, Lockport, and Ontario Power Company on the Brundage Farm at Oakfield, N. Y. Records were kept for five years, and the data given in Table II are taken from the last year ending October 1939. Statistical data on which the operational costs were based are as follows:

Number in family—3 adults, 3 children	Acres—185	Pullets raised—1,200
Size of house—12 rooms	Cattle kept—36	Baby chicks sold—13,000
Type of farm—Dairy, poultry, and crops	Milking cows—18–26	Crops grown—Oats, corn, hay, potatoes, beans
	Horses—4	
	Laying hens—1,100	

The electric rate schedule was:

First 12 kilowatt-hours per month	$1.50 net
Next 48 kilowatt-hours per month	4½ cents per kilowatt-hour
Next 140 kilowatt-hours per month	2½ cents per kilowatt-hour
Excess over 200 kilowatt-hours per month	1½ cents per kilowatt-hour

The data in Table II are by no means complete as to detail in the report itself, but they show

1. The great amount of work accomplished by electricity.
2. The potentiality of the farm as a consumer of electricity.
3. The potentiality as a market for appliances and devices.

It will be noticed first that the yearly bill was more than that of nine urban customers based upon 1942 national average. A total of 6,484 meals was served at a cost of $6.67 per person per year, or 55 cents per month; 6,490 gallons of water were heated at 53.7 cents per person per month; the refrigerator cost ten cents per month per person; 306 individual washings were done at a cost of 89 cents per year, and the ironing was done for 86 cents. In the poultry house an average of 617 hens was lighted, and 1,145 received warm water—24,300 eggs were placed in incubators, and 15,350 chicks hatched, hovered, and brooded. In the dairy an average of 20.2 cows was milked—15,560 gallons of milk were cooled—442,000 gallons of water were pumped—the ventilating system was used 1,041 hours; 120 tons of ensilage were stored at 2.3 cents per ton; 4.05 tons of feed were ground at 36.5 cents per ton; 83 tons of hay and straw were hoisted at a total cost of 36 cents. These data confirm the fact that electricity is the cheapest thing the farmer buys.

We might go on and on with illustrations of what electricity does in the saving of time and labor. Those given,

Table II. Yearly and Average Monthly Consumption and Cost of Energy for Individual Home and Farm Applications on An Experimental Farm

Average Cost Per Kilowatt-Hour—1.817 Cents

Application	Yearly Kilowatt-Hour Consumption	Yearly Cost	Average Monthly Kilowatt-Hour Consumption	Average Monthly Cost
Entire farm	18,897	$343.38	1,575	$28.61
Residence	7,455	135.46	621	11.29
House lighting and small appliances	2,588	47.02	216	3.92
Range	2,201	39.99	183	3.33
Water heater	2,129	38.68	177	3.22
Refrigerator	395	7.18	33	0.60
Ironer	17	0.31	1.5	0.03
Iron	30	0.55	2.5	0.05
Washer	49	0.89	4.1	0.07
Radio	46	0.84	3.9	0.07
Poultry farm	5,766	104.77	481	8.73
Poultry house lights	349	6.34	29	0.52
Poultry water warmers	698	12.68	58	1.05
Incubators	2,990	54.33	249	4.52
Battery brooder	286	5.20	24	0.44
Hover brooders	1,192	21.66	100	1.82
Miscellaneous lights	155	2.82	13	0.23
Shop	96	1.74	8	0.15
Dairy farm	5,445	98.94	454	8.24
Barn lighting	832	15.12	70	1.27
Milking machine	1,024	18.61	85	1.54
Dairy-utensil scalder	1,235	22.44	103	1.87
Milk cooler	1,118	20.31	93	1.69
Water pump	1,105	20.08	92	1.67
Dairy ventilating fans	131	2.38	11	0.20
Portable motor	231	4.20	19	0.35
Silo filling	130	2.36	10.9	0.20
Feed grinding	81	1.48	6.7	0.12
Hay hoisting	20	0.36	1.6	0.03

however, should suffice to give us a concept of the approach to a greater application to farm jobs. But we must not overlook one very important phase of this work, that is, the uplifting influence of lightening the labor of human beings. The morale of farm people is enhanced beyond measure by this new force in their lives. Farming takes on a new dignity, and pride in their profession adds new zest to that strength of character which has always been theirs as one of the most solid segments of our national life.

FARM WIRING

No discussion of this subject would be complete without reference to the importance of a good and adequate wiring system. Good practice dictates today that the distribution center should be so located that service may be most economically and satisfactorily carried to all farm buildings. The farmer who installs electric service should be made to understand the necessity of providing for greater future use. For this reason, adequate copper, both in feeder and branch circuits, should be of such size as to take care of additional load without the need of overhauling the wiring system. The original cost, when the system is first installed, is so small that all the farmer needs is an explanation of its desirability. He is a close buyer but he wants the best. He needs dependable service, and maintenance men are not just around the corner for him.

New farm uses for electricity are not far away. Arc welding, television, dehydration, sharp freezing, and frozen-food storage are some new developments now ready for exploitation. Frozen foods alone present one of the greatest opportunities the electrical industry has ever had. Electronics, in which so much research and experimental work is now going on, offers a tremendous opportunity in plant breeding and propagation. The more agriculture is studied, the wider becomes the horizon for electric service. The wiring system is the very heart of extension of both service and market for appliances and devices. Instead of the average wiring installation being $50, it should be $300 to $500.

FIRST POSTWAR MARKET IS THE FARM

In the postwar period the most immediate market for electrical appliances is the farm. There are three sound reasons for this statement:

1. During the war, when the farmer has been called upon for his greatest production with less man power and equipment, he has learned as never before what electricity means as a *productive* force.

2. The urban industrial worker will be conservative about spending his savings until he finds himself safely in a peacetime job. On the other hand, the farmer will be called upon for at least five years for an even greater production to feed food-famished countries. He therefore has no fears about investment in all kinds of new equipment.

3. The farmer has more money than he has ever had. It is reliably estimated that there will be a farm market for new buildings, repairs, and equipment of $12,000,000,000 in the first two years following the war. The farmer does not have to wait for the money to do this work—he has it *now*.

The electrical industry should get at least ten per cent of this market, but this cannot be done except by better distribution, better sales plans, more promotion, and more advertising. Now is the time to prepare for one of the greatest and one of the most immediate markets. New sales techniques based upon *investment* in labor saving and increased production equipment and appliances must be developed. Know farm jobs better, and sales will be easier and far greater. We have not scratched the surface of possibilities of producing more farm products at less cost by greater applications of electric service.

LOOKING FORWARD

In conclusion, there is another most important reason for the extension of electricity to the business of farming. In the making of a permanent peace following the war, food will be the predominating influence. The American farmer will be called upon for many years for full production. Unless this problem of food is solved successfully, there can be no lasting peace.

This situation has been analyzed as having three distinct periods. The first is relief, when food must be provided quickly for millions of people already starving. Stable governments cannot be founded on riots and revolution which breed on starvation. The second period is defined as that of rehabilitation, when occupied countries as well as those of the United Nations must be provided with machinery and tools, that they again may revive their own agricultural production. The third period is that of reconstruction, wherein agriculture will be developed through greater productive efficiency. This period may take a generation or more, but the American farmer must always keep in the forefront of lowered production costs if he is to compete with cheaper labor of other countries. Otherwise trade barriers which will surely lead to another war will be established.

In a long-range as well as a short-range plan for productive efficiency, electricity can be made a tremendous force. It is not only an opportunity but a responsibility of the entire electrical industry to devote to the fullest its research, its engineering, and its sales ability to the solution of a problem which so fundamentally affects the future welfare of the American people. There can be no prosperity in this country unless agriculture is prosperous—it goes hand-in-hand and side-by-side with industrial production. The harvest, indeed, is rich, and the rewards will come in greatest measure to those who realize and capitalize on the industry's opportunity number one. Not only will we be of service to the American farmer but to the future welfare and peace of our own country and that of the world.

Westinghouse photo

This oil circuit breaker in use on rural-line crossarms automatically recloses twice after opening on short circuit, thus restoring service instantly on the majority of short circuits and maintaining a high degree of service continuity. It has no steel tank but uses the porcelain bushing not only as insulation but as a container for the interrupter and the oil

Evaluation of Incompletely Diversified Loads

W. L. TADLOCK
MEMBER AIEE

IT IS relatively simple to determine the average demands of any particular electric load, but such average data are practically useless for the design of an electric distribution system. Voltage regulation is the factor limiting load on most distribution system components. For this reason, these components can be designed intelligently only on the basis of the recurrent maximum demands of their loads. To the author's knowledge, no proper method of determining such demands has been used previously by electrical engineers. This article presents a method of determining the most probable values of such load demands.

This load-analysis method was developed during the last three years, in order to determine the *pertinent* diversified demands of standard (National Electrical Manufacturers Association) single- and twin-unit 30-gallon uncontrolled electric water heaters. These data, which are not generally available, were secured from field load tests made in Alabama and Georgia in 1939–40. Analysis of the comparative field data on these two heaters indicated that they were essentially equal: in their ability to give water heating service; in their total annual cost to the residential customer; and in their desirability as domestic load.

Intelligent distribution-system design is dependent on proper evaluation of incompletely diversified loads, says this distribution engineer. Such a method of load analysis is set forth in this article.

The majority of the domestic electric load in the southeastern states is composed of lighting, refrigerating, cooking, and water heating equipment. Single-unit uncontrolled electric water heaters furnish the hot water service in most cases. Figure 17 of this paper indicates the most probable recurrent maximum demands which any particular number of these heaters will impose on electric facilities. These recently determined data, along with currently available data on electric lighting, refrigeration, and ranges are indicated on Figure 18. With these empirical data, plus knowledge of the physical location of the domestic loads to be served, the electrical performance of any distribution-system component can be readily calculated.

This load-analysis method can be used to advantage in interpreting properly all electric loads that are not fully diversified. Other domestic loads such as lighting and ranges, commercial-lighting and power loads, and lighting and power loads in military establishments, probably could be served with the use of materially less investment or strategic materials, if their average recurrent maximum demands were better known. It is hoped that this article will contribute to that end.

SERVICE REQUIREMENTS OF UNSTABLE OR INCOMPLETELY DIVERSIFIED LOADS

The capacity of electric distribution systems is usually determined by voltage-drop limitations. In general, this is true where the smallness of the load prohibits the use of voltage regulators. In such cases, the equipment heating effects of the loads involved are relatively unimportant, but it is of first importance to know the magnitude and occurrence frequency of the maximum voltage drops which these loads cause.

Capital investments during peacetime, or the use of strategic materials during wartime to care for those maximum peak loads which occur only occasionally, cannot be justified. Electric-service facilities that will not have excessive voltage drops for those peak loads which recur as often as approximately once every one or two weeks usually can be justified. Greater peak loads than these will occur less often, and smaller peak loads will occur more often. Provision for the larger and less frequent demands is undesirable, whereas the smaller more frequent demands will be served more than adequately by properly designed facilities.

The recurrent demands of loads composed of a relatively small number of load units vary considerably from each other and from their average value. (See Figures 8 and 9.) The demands on distribution-system services have this characteristic most prominently. The progressively better diversified loads on secondary circuits, line transformers, primary feeders, and distribution substations, have this characteristic to a progressively lesser degree.

A GENERAL METHOD OF PROPERLY EVALUATING INCOMPLETELY DIVERSIFIED ELECTRIC LOADS

Figure 13A and Table I illustrate a general method of determining the weighted average value of those maximum distribution-system demands which recur

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The author acknowledges the assistance of H. P. Seelye, L. D. Cronin, W. F. Ogden, and C. T. Brasfield, Jr., in the development of this load-analysis method.

Based upon and developed from a paper presented initially at the conference on analysis of military loads and postwar application, AIEE winter technical meeting, New York, N. Y., January 25–29, 1943.

sufficiently often to justify system capacity to serve them. In addition, Table II illustrates a general method of determining unknown total or *composite* load values of demand and their recurrence frequencies, from known *component* load values. Both of these supplementing load-analysis methods are based on the use of the class frequency-distribution polygon.[1] In Figure 13A, the assumed occurrence frequency or probability of demands in any particular two-kilowatt demand interval is plotted against the mid-point of that particular demand interval. If sufficient demand data on any particular load can be secured from actual field tests, the characteristics of that load can be determined definitely from the corresponding demand frequency-distribution polygon.

The individual demands of such a polygon are mutually exclusive. Therefore the probability that some *one* of any particular number of demands will occur equals the sum of the individual probabilities (ΣP) corresponding to those particular demands. The weighted average value of those maximum demands having any particular total probability of occurrence, therefore, equals the sum of the moments of the individual demand probabilities about the zero-demand axis, $\Sigma(DP)$, divided by the sum of the individual demand probabilities, ΣP. This average-maximum-demand value will be referred to hereafter as $D_{\text{avg max}}$. In Table I, all values of $D_{\text{avg max}}$ [equal to $\Sigma(DP)/\Sigma P$] within the limits of the assumed data are calculated. The results are indicated graphically in Figure 13A by the curves marked "days." The value of the $D_{\text{avg max}}$ recurrence period in days (equal to $1/\Sigma P$) is used as being more significant than the total occurrence probability ΣP.

The demands of a group of five electric water heaters are independent of the demands of a group of ten electric ranges. By considering the assumed demands for such independent loads (graphically indicated in Figure 13A and tabulated in Table II), it can be seen that any one of the four heater demands may concur with any one of the independent nine range demands, or, there are 36 possible coincident or composite demands. However, the probability of occurrence of any one of these 36 possible composite demands, D_h+D_r, equals the product of the corresponding component demand probabilities, P_hP_r. Similarly, for three or more groups of mutually independent electric loads (such as heaters, ranges, lighting, . . .), the probability of any particular component load-demand concurrence, $D_h+D_r+D_l+\ldots$, is the product of the corresponding component load probabilities, $P_hP_rP_l\ldots$. A composite load-demand frequency-distribution polygon may be determined from sufficient data on the component loads as follows:

1. Determine all of the possible sums of the component load demands, $D_h+D_r+D_l+\ldots$.

2. Determine $P_hP_rP_l\ldots$ for each of the values $D_h+D_r+D_l+\ldots$.

3. Group the values of $D_h+D_r+D_l+\ldots$ by demand intervals of proper size (one or two kilowatts). Thereafter use the mid-point

Table I. Determination of the Average of the Recurrent Maximum Demands, Whose Total Probability of Occurrence (or Frequency of Recurrence) Is Any Desired Value, From Complete Demand Versus Frequency Data. *Results Indicated Graphically in Figure 13A

D* Diversified Demand (Kw)	P* Probability (%/100)	DP	ΣP	Σ(DP)	Average Maximum Demands (Kw) Σ(DP)/ΣP	Maximum-Demand Recurrence Period (Days) 1/ΣP
For 5 Water Heaters						
7	0.035	0.245	0.035	0.245	7.00	28.6
5	0.193	0.965	0.228	1.210	5.31	4.39
3	0.422	1.266	0.650	2.476	3.81	1.54
1	0.350	0.350	1.000	2.826	2.83‡	1.00
For 10 Ranges						
17	0.01	0.17	0.01	0.17	17.0	100.
15	0.02	0.30	0.03	0.47	15.7	33.3
13	0.05	0.65	0.08	1.12	14.0	12.5
11	0.10	1.10	0.18	2.22	12.3	5.56
9	0.17	1.53	0.35	3.75	10.7	2.86
7	0.22	1.54	0.57	5.29	9.28	1.76
5	0.19	0.95	0.76	6.24	8.22	1.32
3	0.15	0.45	0.91	6.69	7.35	1.10
1	0.09	0.09	1.00	6.78	6.78‡	1.00
For 5 Water Heaters and 10 Ranges**						
24	0.00035	0.00840	0.00035	0.00840	24.0	2860.
22	0.00263	0.0579	0.00298	0.0663	22.2	336.
20	0.00983	0.197	0.01281	0.263	20.5	78.1
18	0.02509	0.452	0.03790	0.715	18.9	26.4
16	0.05335	0.854	0.09125	1.57	17.2	11.0
14	0.10021	1.40	0.19146	2.97	15.5	5.22
12	0.15585	1.87	0.34731	4.84	13.9	2.88
10	0.19426	1.94	0.54157	6.78	12.5	1.85
8	0.18928	1.51	0.73085	8.29	11.3	1.37
6	0.14717	0.883	0.87802	9.17	10.5	1.14
4	0.09048	0.362	0.96850	9.53	9.83	1.03
2	0.03150	0.0630	1.00000	9.60	9.60‡	1.00

* All examples of values of D and P are for mid-points of two-kilowatt load intervals.

** See Table II for an example of the general method of calculating unknown composite load values of D and P from known component load values of D and P.

‡ Average daily demand.

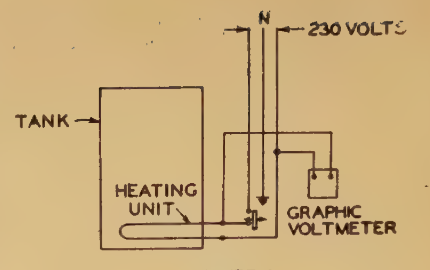


FIGURE 1

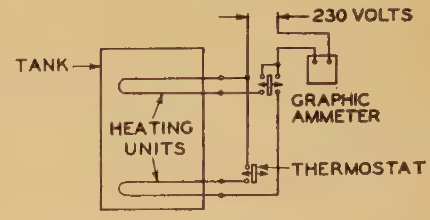


FIGURE 2

Figure 1. Schematic connection diagram used for load tests on NEMA standard 30-gallon single-unit 1,500-watt electric water heaters. Graphic voltmeter connected for 230-volt operation

Figure 2. Same as Figure 1, except for twin-unit heaters with 600-watt bottom unit and 1,000-watt top unit electrically interlocked for 1,000-watt maximum demand. Graphic ammeter records loads

Figure 3. Sample graphic voltmeter chart depicting demands of a single-unit heater connected as in Figure 1

Any voltmeter reading indicates 1.5-kw heater demand. No reading indicates zero demand

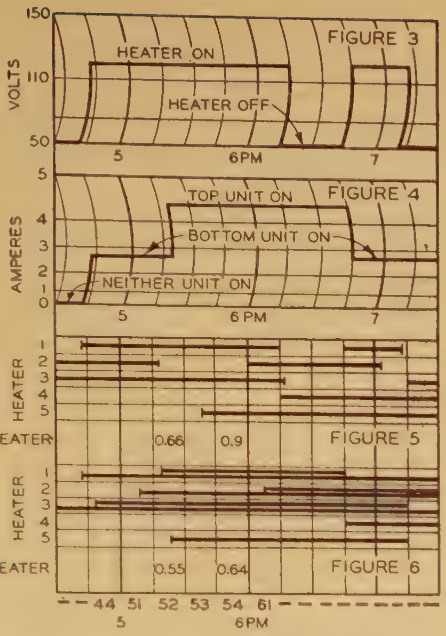


Figure 4. Sample graphic ammeter chart depicting demands of twin-unit heater connected as in Figure 2

Upper reading indicates 1,000-watt top-unit demand. Lower reading indicates 600-watt bottom-unit demand. No reading indicates zero demand

Figure 5. Condensed graphical summary of coincident load data for five single-unit heaters

Heavy horizontal lines indicate heaters "on," at 1.5 kw each. Breaks in lines indicate heaters "off." Line 1 indicates load data of Figure 3. By adding and interpreting the horizontal "load lines" crossing each vertical time column, the diversified 15-minute demand, per heater, for a group of five heaters was secured, as indicated at bottom of two sample columns

Figure 6. Same as Figure 5, except for five twin-unit heaters

Line 1 indicates load data of Figure 4. Doubled horizontal lines indicate 1,000-watt upper-unit operation. Single lines indicate 600-watt bottom-unit operation. No line indicates inoperative heater

value of any particular demand interval to designate all values of $D_h+D_r+D_l+\ldots$ falling in that interval.

4. Add values of $P_hP_rP_l\ldots$ corresponding to all values of $D_h+D_r+D_l+\ldots$ falling in the same demand interval.

5. Plot values of $P_c=\Sigma(P_hP_rP_l\ldots)$ corresponding to each composite load-demand-interval mid-point, D_c. The result is a representative composite-load-demand frequency-distribution polygon.

Such a composite-load polygon, for two component loads (heaters and ranges) is determined in Table II and illustrated at bottom of Figure 13A. $D_{avg\ max}$ for this calculated composite load, is determined at bottom of Table I and illustrated by the curve marked "days" at the bottom of Figure 13A.

Composite, or total, residential-load values of $D_{avg\ max}$ are the ones for which line-transformer secondary-circuit combinations must be designed. However, with the aid of the two previously outlined load-analysis methods, these composite-load demands can be determined adequately from considerably less component-load-demand data than composite-load-demand data. For instance, adequate demand data on composite residential loads (measured at line transformer) consists of representative demand data on all of the possible combinations of, say, 1, 5, 10, 20, and 30 residential lighting loads; 1, 5, 10, 20, and 30 ranges; and 1, 5, 10, 20, and 30 water heaters. Assuming that there cannot be more ranges or water heaters than lighting customers, on a particular circuit, there are still 50 different possible combinations of these component loads for which representative composite-load-demand data (measured at the line transformer) would have to be secured. In other words, the necessary data for the construction of approximately 50 composite-load-frequency polygons would be required in order to evaluate properly the various residential load demands on line-transformer secondary-circuit combinations. Compared with this, representative-demand data on only five different-sized groups of lighting loads, five different-sized groups of range loads, and five different-sized groups of heater loads (15 total component-load groups) are required. Actually, all component-load data required can be determined from representative-demand data on 30 individual lighting customers, 30 individual ranges, and 30 individual water heaters (90 total individual-load units). As residential loads are physically distributed, demand data on individual lighting, range, or heater loads, rather than on grouped loads, are inherently easier to secure. Adequate demand data on 30 individual component-load units can be combined numerically, as described later in this article, to give the diversified-demand data required for groups of 1, 5, 10, 20, or 30 component-load units.

In order to determine $D_{avg\ max}$ for all representative composite residential loads, approximately 50 composite-load-frequency polygons must be finally determined in either case. If composite-load demands are metered at the line transformer, a relatively large amount of field-test data, but relatively little computing labor, is required. If the demands of individual component-load units are metered, a relatively small amount of field-test data, but a relatively large amount of computing labor, is required.

RESIDENTIAL LOAD DEMANDS DETERMINED FROM LIMITED FIELD-TEST DATA

Even adequate component-residential-load data are quite difficult to secure. When such data are not too meager, however, composite-load demands can still be determined with reasonable accuracy by employing a modified form of the general methods outlined. An example of the use of these modified analysis methods is given in Table III. The limited component-load data and the calculated composite-load demands are illustrated in Figure 13B.

The essential difference between the general and modified analysis methods is that in the general method, the component-load-frequency polygons are determined by plotting the variable probability values against the

corresponding constant-demand-interval mid-points, while in the modified method, the component-load polygons are determined by plotting a constant value of demand-occurrence probability against the corresponding variable values of the individual recurrent demands. In the modified method, the constant value of probability equals one divided by the number of individual recurrent demands in the limited data, or, it is assumed that within the limits of the available data, each recurrent-demand value has the same weight, or probability of occurrence.

On this basis, as indicated in Table III and illustrated in Figure 13B, the probability of all individual composite demands is also a constant, equal to the product of the two or more constant component-demand probabilities. Component-load values of $D_{\text{avg max}}$, determined by the modified method, equal the simple numerical average of those maximum demands having a total probability of occurrence ΣP equal to nP (where n equals the number of maximum demands averaged and P equals the constant probability of each individual demand).

Table II. Calculation of Composite Load Demands (D_c) and Their Occurrence Probabilities (P_c) From Known Demand and Occurrence-Probability Data for Two Component Loads (Five Water Heaters and Ten Ranges). Data Further Analyzed in Table I and Illustrated in Figure 13A

D_h* Diversified Demand (Kw)	D_r* Diversified Demand (Kw)	D_c* (D_h+D_r) (Kw)	P_h* Probability (%/100)	P_r* Probability (%/100)	P_hP_r
1	1	2	0.35	0.09	0.03150
1	3	4	0.35	0.15	0.05250
1	5	6	0.35	0.19	0.06650
1	7	8	0.35	0.22	0.07700
1	9	10	0.35	0.17	0.05950
1	11	12	0.35	0.10	0.03500
1	13	14	0.35	0.05	0.01750
1	15	16	0.35	0.02	0.00700
1	17	18	0.35	0.01	0.00350
3	1	4	0.422	0.09	0.03798
3	3	6	0.422	0.15	0.06330
3	5	8	0.422	0.19	0.08018
3	7	10	0.422	0.22	0.09284
3	9	12	0.422	0.17	0.07174
3	11	14	0.422	0.10	0.04220
3	13	16	0.422	0.05	0.02110
3	15	18	0.422	0.02	0.00844
3	17	20	0.422	0.01	0.00422
5	1	6	0.193	0.09	0.01737
5	3	8	0.193	0.15	0.02895
5	5	10	0.193	0.19	0.03667
5	7	12	0.193	0.22	0.04246
5	9	14	0.193	0.17	0.03281
5	11	16	0.193	0.10	0.01930
5	13	18	0.193	0.05	0.00965
5	15	20	0.193	0.02	0.00386
5	17	22	0.193	0.01	0.00193
7	1	8	0.035	0.09	0.00315
7	3	10	0.035	0.15	0.00525
7	5	12	0.035	0.19	0.00665
7	7	14	0.035	0.22	0.00770
7	9	16	0.035	0.17	0.00595
7	11	18	0.035	0.10	0.00350
7	13	20	0.035	0.05	0.00175
7	15	22	0.035	0.02	0.00070
7	17	24	0.035	0.01	0.00035
Totals			7.000	4.00	1.00000

Calculated Composite Values for Five Water Heaters and Ten Ranges**

D_c* (D_h+D_r) (Kw)	P_c* $\Sigma(P_hP_r)$ (%/100)
2	0.03150
4	0.09048
6	0.14717
8	0.18928
10	0.19426
12	0.15585
14	0.10021
16	0.05335
18	0.02509
20	0.00983
22	0.00263
24	0.00035
Total	1.00000

* D_h, D_r, and D_c represent heater range, and composite (heater and range) demands, respectively. P_h, P_r, and P_c represent heater, range, and composite demand occurrence probabilities, respectively.

** For any particular value of D_c, P_c equals $\Sigma(P_hP_r)$. For example (D_c=6.0 kw), P_c=(0.0665+0.0633+0.01737)=(0.14717).

SUM OF TWO OR MORE COMPONENT-LOAD VALUES OF $D_{\text{avg max}}$ APPROXIMATELY EQUAL TO $D_{\text{avg max}}$ FOR COMPOSITE LOAD

A study of particular sets of component-load data, which were analyzed by means of the modified analysis methods, indicated that a component-loads contribution to the composite-loads $D_{\text{avg max}}$ varies with the sizes of the other component loads. For example, the part of $D_{\text{avg max}}$, on a line transformer, caused by five water heaters, is somewhat less when the transformer also serves ten ranges than when the transformer also serves just five ranges.

This being the case, it follows that composite-load values of $D_{\text{avg max}}$ cannot be determined *exactly* from

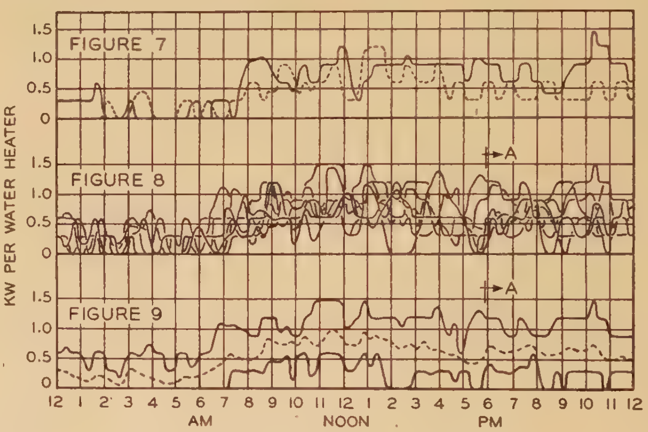


Figure 7. Example of how distribution-system component load curves do not repeat themselves even for same day of week

Solid curve represents diversified 15-minute kw demands, per heater, for a group of five 1,500-watt single-unit water heaters on one Saturday. Dotted curve is for same heaters on following Saturday

Figure 8. The same data as Figure 7, except for seven five-heater groups on successive Saturdays

Figure 9. Example of how distribution-system loads for a particular day vary from the average load for that day

Solid lines are envelope of the maximum and minimum 15-minute demand values of Figure 8. The dotted line represents the average heater demands of Figure 8

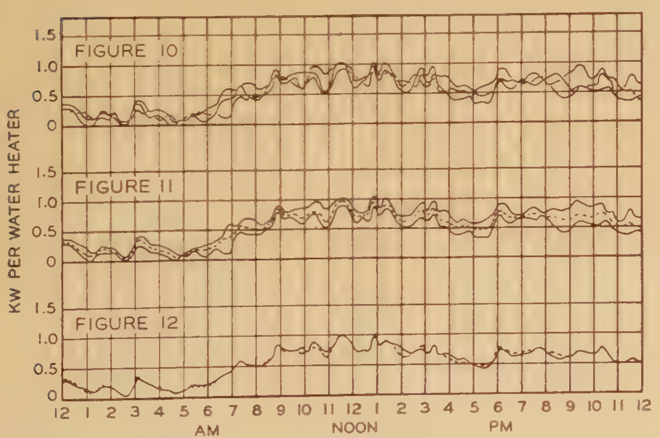
component-load values of $D_{avg\ max}$. For example, by referring to Figures 13A and 13B, it is seen that those composite-load values of $D_{avg\ max}$, which occur every n^2 days, are from zero per cent to nine per cent larger than the sums of the heater and range values of $D_{avg\ max}$ which occur every n days. However, until sufficient load data have been analyzed to determine the previously described composite-residential-load-demand polygons (for approximately 50 combinations of component loads) we have no choice but to approximate composite-load values of $D_{avg\ max}$ from available data on component-load values of $D_{avg\ max}$.

In distribution-system design this approximation appears to be sufficiently accurate for all practical purposes.

ACTUAL DETERMINATION OF DIVERSIFIED WATER-HEATER DEMANDS FROM FIELD-TEST DATA

In the winter of 1939–40, 15-minute demand data on 34 heater-weeks of single-unit water-heater operation and 34 heater-weeks of twin-unit water-heater operation were secured in Alabama and Georgia (see Figures 1–4). Single- and twin-heating elements were alternated in the same heater tanks (serving the same customers) for these tests. Test data on these heaters also were secured during the summer of 1939, but as the winter demands were found to be roughly 50 per cent greater, due to the lower winter inlet-water temperatures, only the winter demands were analyzed further.

The graphic-meter-chart data were condensed, for further analysis, on lengths of cross-section paper as indicated in Figures 5 and 6. Twenty-four-hour time scales were laid out horizontally by a code numbering of 96 consecutive columns to correspond to the 96 quarter hours per day.



Figures 10 and 11. Same as Figures 8 and 9, respectively, except curves for three 20-heater-group Saturdays. These curves illustrate the increase in stability of diversified loads with increase in number of load units per load group

Figure 12. Solid and dotted curves, respectively, are the average-demand curves of Figures 9 and 11. These curves illustrate the fact that the average demands, per load unit, for a five-load-unit group and any other sized group, are identical

After the 34 heater-weeks of graphic-meter demand data were condensed in this manner, they were subdivided into seven groups of five heater-weeks per group (demand data on one heater-week was used once, in each of two groups, in order to complete the seventh five-heater group from 34 heater-weeks of data). Then, the diversified demands of each of the seven groups were determined for each 15-minute period of each day of the week by adding and interpreting the horizontal "load lines" crossing each time column (see Figures 5 and 6).

Actual winter Saturday diversified-demand curves for five-heater groups of single-unit water heaters are indicated in Figures 7 and 8.

After the diversified demands, per heater, were determined for the seven five-heater-week groups, the diversified demands, per heater, for ten-heater-week groups were determined by averaging the diversified demands of two five-heater-week groups (by adding these demands and dividing the sums by two). Diversified demands for four ten-heater-week groups were secured, in this way, from four pairs of five-heater-week groups. The four pairs were formed by using six of the seven groups, once each, and one of the seven groups, twice. Similarly, the diversified demands, per heater, for three 20-heater-week groups were determined from the diversified demands per heater, of the four ten-heater-week groups.

Actual winter Saturday diversified-demand curves for 20-heater groups of single-unit water heaters are indicated in Figure 10.

ACTUAL DETERMINATION OF $D_{avg\ max}$ FOR WATER HEATERS

Comparison of diversified heater demands, for the various days of the week, disclosed that there was considerable variation in these daily demands, even for the same time of day. For instance, Thursday heater demands were considerably greater at time of distribution-system peak demand (5:45 p.m.) than any other day's demands.

In view of this day-to-day variation, values of $D_{avg\ max}$ for water heaters (for each 15-minute period of the day) were determined first for each day of the week and then for the entire week by averaging the daily values. The numerical average of six of the daily values of $D_{avg\ max}$ (for each 15-minute period of the day) was determined as being the most probable component of the distribution-circuit $D_{avg\ max}$ caused by water heaters. Hereafter, week averages of daily values of $D_{avg\ max}$ will be referred to as $D'_{avg\ max}$. Because Sunday heater demands were relatively low, they were not used in determining values of $D'_{avg\ max}$. The author now does not believe this omission was proper, however.

Because we analyzed heater demands by individual days of the week, the data which we could use to determine values of $D_{avg\ max}$ were limited to only one seventh

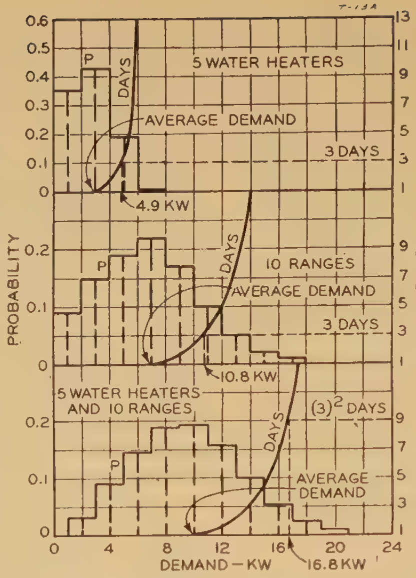


Figure 13A. Top and center of figure are assumed diversified demand-frequency versus demand-interval polygons for a group of five water heaters and for a group of ten ranges during the period 5:45-6:00 p.m. on Saturday. Bottom of figure indicates the calculated frequency versus demand-interval polygon for the composite heater and range demands at the same time on that day

Curves, labeled "days," indicate the average value ($D_{avg\ max}$) of those maximum demands which have the indicated recurrence period in days. The recurrence period of one day, on these curves, coincides with the average daily demand (or the average of those demands which recur every day). The value of the composite load $D_{avg\ max}$, recurring every n^2 days, equals approximately the sum of the component load values of $D_{avg\ max}$ recurring every n days. For example, the composite load $D_{avg\ max} = 16.8$ kw, recurring every nine days, approximately equals the sum of the heater load $D_{avg\ max} = 4.9$ kw and the range load $D_{avg\ max} = 10.8$ kw, each recurring every three days

of the total. However, reasonably stable values of $D_{avg\ max}$ were determined from these data by means of the modified analysis method, previously described (see Figure 13B and Table III).

To determine actual values of $D_{avg\ max}$ for water heaters, the unweighted average of those recurrent maximum demands, representing 3/7 of the total number of recurrent demands, was calculated. In line with previously outlined principles, the total occurrence probability of this number of recurrent maximum demands is 3/7, or once every 2.33 days. Assuming that equivalent data on electric-range and lighting-load demands are available, the composite- (or distribution-circuit) load values of $D_{avg\ max}$ (approximately equal to the sum of the lighting, range, and heater values of $D_{avg\ max}$) would recur every $(2.33)^3$ days, or approximately every 12 or 13 days. This maximum-demand recurrence period is approximately correct for design purposes.

To determine $D_{avg\ max}$ per water heater, for each 15-minute period of each day of the week we:

1. Averaged the 15 recurrent maximum demands, constituting approximately 3/7 of the 34 total recurrent demands, for one heater.

2. Averaged the three recurrent maximum diversified demands, constituting 3/7 of the seven total recurrent diversified demands, for groups of five heaters (this is illustrated, for Saturday demands, in Table IV).

3. Took the weighted average of the first maximum demand and 5/7 of the second maximum demand (added first demand to 5/7 of second demand and divided sum by 1 5/7) constituting 3/7 of the four total recurrent diversified demands, for groups of ten heaters.

4. Took the weighted average of the first maximum demand and 2/7 of the second maximum demand, constituting 3/7 of the three total recurrent diversified demands, for groups of 20 heaters.

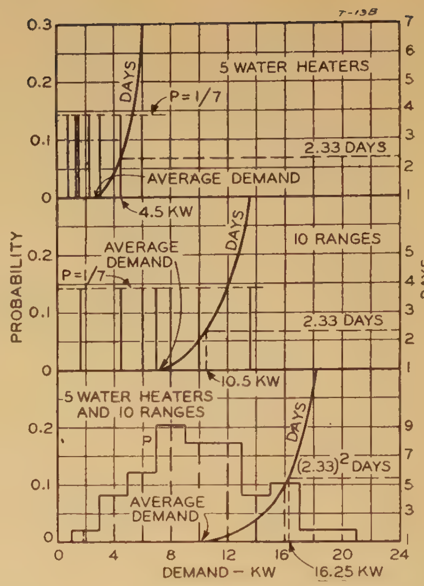


Figure 13B. Same as Figure 13A, except top and center of figure depict data so limited in quantity that a special form of frequency–demand diagram is employed, wherein individual recurrent demands, instead of demand-interval mid-points, are plotted. Top of figure depicts the actual recurrent Saturday total water-heater demands corresponding to those indicated in curve form in Figures 8 and 9, at Section A-A. Center of figure depicts assumed similar data for ten electric ranges

$D_{avg\ max}$ can be determined, from data in this form, by simply averaging the desired number of the recurrent maximum individual demands, as indicated and justified in Table III

After values of $D_{avg\ max}$ had been calculated, for each 15-minute period of each day of the week, their unweighted Monday–Saturday week average was calculated, for each 15-minute period of the day. As previously explained this value of $D'_{avg\ max}$, for each 15-

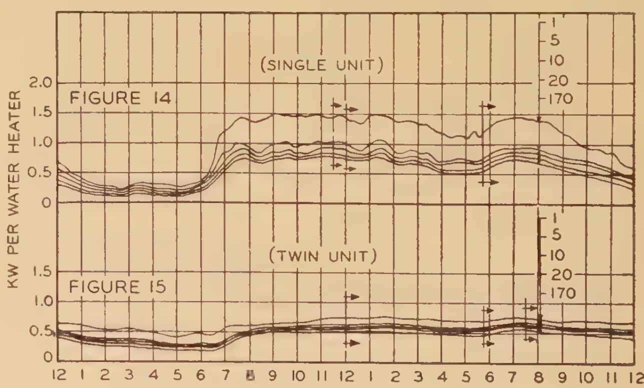


Figure 14. $D'_{avg\ max}$, or winter, week averages of the daily average maximum diversified demands ($D_{avg\ max}$) of single-unit 1,500-watt 30 gallon NEMA standard uncontrolled electric water heaters, in 1, 5, 10, 20, and 170 heater groups

Figure 15. Same as Figure 14, except demands ($D'_{avg\ max}$) of twin-unit NEMA standard water heaters, having 600-watt bottom units and 1,000-watt top units, with units interlocked for 1,000-watt maximum demand

minute period of the day, was considered to represent the most probable component of the distribution-circuit $D'_{\text{avg max}}$ caused by water heaters. Figures 14 and 15 depict the calculated values of $D'_{\text{avg max}}$ for single- and twin-unit water heaters. The curves on Figures 14 and 15, for 170 heater-days (5×34 heater-days), depict the Monday–Friday week-average demands of the average water heater. By comparing the curve of $D'_{\text{avg max}}$ for 20 heaters, with this curve of the average demand of the average heater it can be seen that the values of the former are only slightly greater than the values of the latter. We may conclude from this that the demands of 20 water heaters are almost completely diversified.

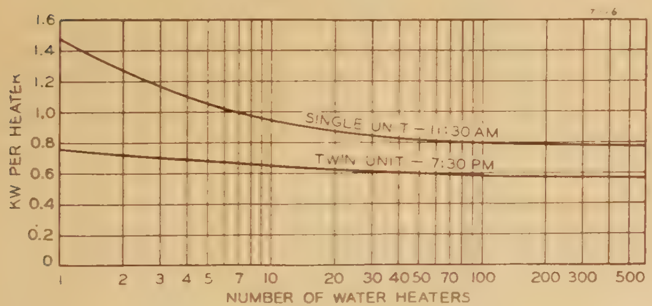
The values of $D'_{\text{avg max}}$ on Figures 14 and 15 are presented in more usable form in Figures 16 and 17.

RELATIVE CHARACTERISTICS OF SINGLE- AND TWIN-UNIT UNCONTROLLED HEATERS

Examination of Figures 16 and 17 discloses that the values of $D'_{\text{avg max}}$ for uncontrolled single-unit heaters are larger than those for equivalent uncontrolled twin-unit heaters. However, examination of Figures 14, 15, and 17 discloses that this difference is not so great, at the time of the circuit peak (5:45 p.m.).

Analysis of the comparative 1939–40 field-test data, on single- and twin-unit NEMA standard 30-gallon uncontrolled electric water heaters, indicated in general that:

1. The two heaters gave essentially equal domestic water-heating services.



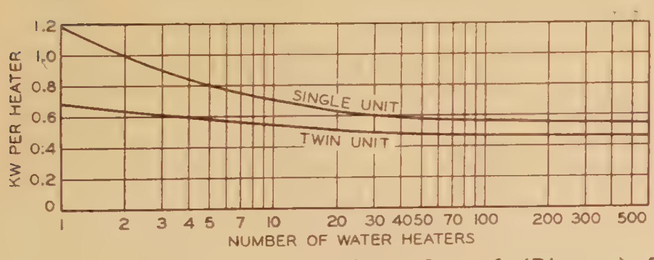


Figure 16. Winter average maximum demands ($D'_{\text{avg max}}$) of various numbers of water heaters, from "peak demand" cross sections of 24-hour demand curves of Figures 14 and 15

Figure 17. Winter average maximum demands ($D'_{\text{avg max}}$) of various numbers of water heaters, at time of distribution-system peak demand (5:45 p.m.). Data from 5:45 p.m. cross sections of Figures 14 and 15

2. The single-unit heater had greater demands (see Figures 16 and 17) and required approximately six per cent more energy than the twin-unit heater.

3. The single-unit heater was simpler and had a lower first cost than the twin-unit heater.

4. The sum of the domestic customer's operating and fixed costs was essentially the same for the two heaters.

5. The two heaters were equally desirable domestic loads.

6. It is possible to exercise "partial off-peak control" of the twin-unit heater at some reduction in heating capacity, a function not possible with the single-unit heater.

DESIGN OF DOMESTIC ELECTRIC-SERVICE FACILITIES

The values of $D'_{\text{avg max}}$ for various numbers of single-unit uncontrolled electric water heaters, determined by the modified analysis method outlined herein, is now being used in several of the southeastern states in the design of domestic electric-service facilities. These calculated data, along with modified empirically determined data for electric ranges,[2] refrigerators,[3] and lighting and miscellaneous demands,[4] were assembled on one curve sheet for use by distribution engineers in

Table III. Same as Table I, Except for Limited Field Data. Results Indicated Graphically in Figure 13B

D Diversified Demand (Kw)	P Probability (%/100)	DP	ΣP	Σ(DP)	Average Maximum Demands (Kw) Σ(DP)/ΣP	Maximum-Demand Recurrence Period (Days) 1/ΣP
For 5 Water Heaters*						
6.00	1/7	6.00P	1P	6.00P	6.00	7.00
4.50	1/7	4.50P	2P	10.50P	5.25	3.50
3.00	1/7	3.00P	3P	13.50P	4.50**	2.33
2.25	1/7	2.25P	4P	15.75P	3.94	1.75
1.50	1/7	1.50P	5P	17.25P	3.45	1.40
1.50	1/7	1.50P	6P	18.75P	3.12	1.17
0.75	1/7	0.75P	7P	19.50P	2.79‡	1.00
For 10 Ranges*						
13.6	1/7	13.6P	1P	13.6P	13.6	7.00
10.0	1/7	10.0P	2P	23.6P	11.8	3.50
8.0	1/7	8.0P	3P	31.6P	10.5**	2.33
7.0	1/7	7.0P	4P	38.6P	9.6	1.75
6.0	1/7	6.0P	5P	44.6P	8.9	1.40
4.5	1/7	4.5P	6P	44.1P	8.1	1.17
1.7	1/7	1.7P	7P	50.8P	7.26‡	1.00
For 5 Water Heaters and 10 Ranges‡‡						
20	0.0204	0.408	0.0204	0.408	20.0	49.0
18	0.0204	0.368	0.0408	0.776	19.0	24.5
16	0.102	1.63	0.1428	2.41	16.9	7.00
14	0.0816	1.14	0.2244	3.55	15.8	4.46
12	0.1736	2.08	0.3980	5.63	14.1	2.51
10	0.1736	1.74	0.5716	7.37	12.9	1.75
8	0.2044	1.63	0.7760	9.00	11.6	1.29
6	0.122	0.732	0.8980	9.73	10.8	1.11
4	0.0816	0.326	0.9796	10.1	10.3	1.02
2	0.0204	0.0408	1.0000	10.1	10.1‡	1.00

* $\Sigma(PD)/\Sigma P$ reduces to $(\Sigma D)/n$ for these limited data wherein D represents individual recurrent demands instead of demand-interval mid-points. n is the number of maximum-demand values whose average value is to be determined.

** Average maximum demands having $\Sigma P = 3/7$.

‡ Average daily demand.

‡‡ Composite load demands and probabilities (for 5 heaters and 10 ranges) determined by simply counting the number of possible sums of $(D_h + D_r)$ which fall in each of the ten two-kilowatt demand intervals. The number of sums in each demand interval multiplied by $[1/49 = (1/7)(1/7)] = \Sigma P_h P_r = P_c$.

Table IV. Diversified Recurrent Saturday 15-Minute Kilowatt Demands, Per Heater, for Groups of Five Single-Unit Water Heaters.* Individual and Average Saturday Demand Data Indicated Graphically in Figures 8 and 9

								†			
Heater Group—Saturdays 1	*0.60*	*0.60*	*0.45*	0.30	0.90	*1.02*	*1.32*	*1.20*	*1.20*	*0.90*	*0.60*
2	0.30	0.12	*0.30*	*0.30*	0.84	*1.02*	*0.30*	0.30	0.60	*0.90*	*0.90*
3	0.00	0.00	0.00	0.12	0.57	0.30	0.30	*0.60*	0.60	*0.60*	0.30
4	0.30	*0.30*	0.06	0.00	*1.14*	0.90	0.00	0.15	0.42	0.30	*0.78*
5	*0.30*	0.15	0.00	0.00	0.54	0.30	0.06	0.45	*0.75*	0.30	0.30
6	*0.60*	*0.69*	0.12	*0.30*	*0.90*	*0.90*	*0.90*	*0.90*	*1.14*	0.30	0.30
7	0.00	0.00	*0.45*	*0.60*	*1.47*	0.66	0.30	0.30	0.48	0.60	0.30
Sum of Three Maximum Demands	1.50	1.59	1.20	1.20	3.51	2.94	2.52	2.70	3.09	2.40	2.28
Average of Three Maximum Demands ($D_{avg\ max}$)	0.50	0.53	0.40	0.40	1.17	0.98	0.84	0.90	1.03	0.80	0.76
(96) Coded 15-Minute Time Periods	121	122	54	61	114	121	53	54	61	113	114
	12		6 a.m.		12 noon			6 p.m.			12

*Italic figures indicate the three maximum demands, in seven recurrent Saturdays, for a particular time of day.

† Column of data, corresponding to total demands, analyzed in Table III and illustrated at top of Figure 13B.

determining the composite, or total, load values of $D'_{avg\ max}$. These complete demand data are indicated in Figure 18.

With the load data indicated in Figure 18, and knowledge of the physical location of the domestic load

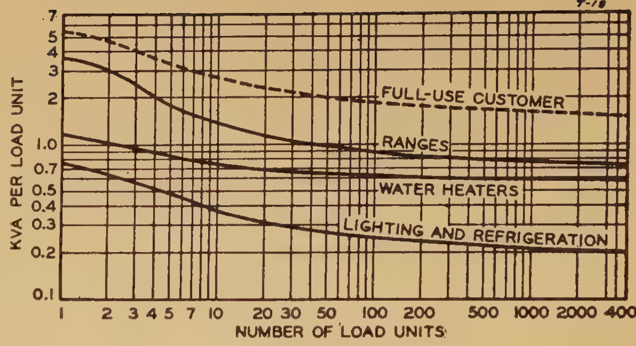


Figure 18. Most probable values of average maximum diversified demand ($D'_{avg\ max}$) for residential customers, electric ranges, and electric water heaters. Dotted curve indicates demands of "full use" customers, all of whom have lights and refrigerators, ranges, and water heaters. These data are based on 100 per cent electric-refrigerator saturation as representative of the majority of new residential customers

to be served, the electrical performance of any electric distribution-system component can be readily calculated.

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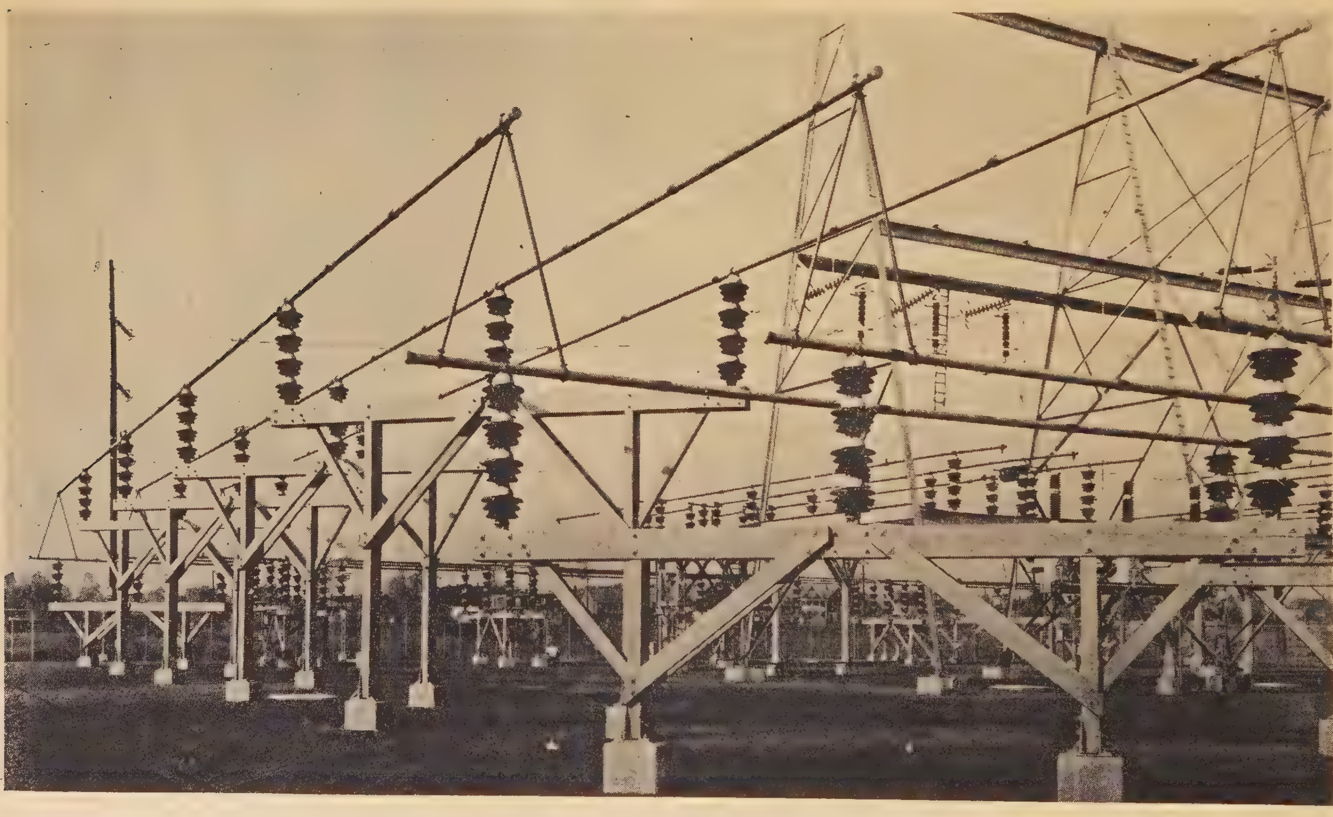

Wood beams top steel columns in this 26-kv wartime-built substation of the Public Service (N. J.) Electric and Gas Company

Wartime Trends in Arc Welding

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ASSOCIATE AIEE

Arc welding has made considerable progress in the past several years, much of it as a direct result of the war. The contributions made by the three big factors in arc welding—technique, electrodes, and machines—to the development of the science are evaluated in this article.

ONE of the strangest inconsistencies in our modern industrial world is that, although we consider ourselves the most progressive people in the world, a wonderful tool or a revolutionary improvement will often lie unrecognized, unclaimed, and unsupported, until we are forced by war or national catastrophe to examine and use it. Oftentimes the torch of this work has been carried by some toiling inventor, often by a little-known but determined organization, and many times by some farseeing industrialists.

Such was the story, in a sense, of arc welding. Its story has been a rough and stormy one, not always pleasant. Electric arc welding, like aviation, got its first real opportunity during World War I, but, unlike the American planes which did get to the front and show their merit, very few arc-welded products ever came within the sound of battle—most of them were still in the assembly stage when the armistice brought to an end the four long years of World War I. As a result, welded ships were almost 20 years away, welded tanks 24 years, welded railcars 16 years.

But in passing these milestones, the science of arc welding has grown beyond the wildest dreams of its pioneers. Today every column of welding statistics looks like a pyramid; all of the graphs run off the top edge of the sheet while dollar volume has had a habit of doubling itself every year recently.

In 1938, only a little more than five years ago, electric welding was an $18,000,000 industry. According to the best estimates, sales of arc-welding equipment exceeded $128,000,000 in 1942. Of this sum, over $46,000,000 was spent on new machines. Back in 1938 industry purchased $4,000,000 worth of new welders. Gas welding, however, during the same period, did not increase anywhere near this proportion. More money was spent in 1941 and 1942 on arc-welding equipment than had been spent in the previous 25 years combined.

Figures and statistics are not very informative at times and really tell us little of true progress in the science of welding with the electric arc.

While the average designer still puts a half-inch fillet where a quarter-inch one would be more than sufficient, and while blueprints even today come into the shop marked for welding on the inside where not even the welding foreman can get his electrode holder, let alone the welding rod, arc welding of today has made much progress. Much of this progress has been a direct result of the war, and, during the course of this discussion we should like to evaluate this progress to date and, in so doing, gain a glimpse of what we may expect from the future.

In arc welding there are three big variables, each dependent on the other, yet each distinct in its own importance—technique, electrodes, and machines. When all three are working together correctly, arc welding is at its best. Success without this mutual co-operation is sheer luck. Let us take these three variables, one by one, and analyze how war has brought improvement to them.

It was not so many years ago when the entire choice of the welding was left to the welder on the job. Such, in fact, is still the case in some plants. Fortunately, for arc welding, the average old-time welder was master of the art, a combination metallurgist, designer, engineer, and magician. His work was often surrounded with much mystery—seldom even did the superintendent question his methods. One of the strangest facts in the history of arc welding was that, while in one plant welding technique was left to luck or to the skill of the welder, another factory doing similar work for years had been making studies and tests of the possibilities of this new fabricating method and was utilizing this knowledge to better its product through scientific design, incorporating as much welding as possible in its product.

When the first *Panzer* divisions overran Poland in September 1939, and Britain and France began to purchase vast quantities of war material in the United States, those plants which had left arc welding for repairs and continued to rivet, bolt, or cast their various parts were beginning to suffer. There is no place on the battlefield for a tank or gun or jeep, that is "almost as good." Most large industries began to buy welding equipment almost frantically, only to find that for some reason or other their welds would crack wide open as they cooled, or would warp and distort the assembly beyond repair. Soon the men in charge began to realize that here was too important a part of production to trust it to luck. The solution—to submit each new

Essential substance of a paper presented at the AIEE South West District technical meeting, Kansas City, Mo., April 28–30, 1943.

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welded design to a man who knew all about welding. He must be a good engineer, a metallurgist, a cost analyst, and, most of all, a marvelous diplomat and psychologist. Such an individual became known as the "welding engineer." Unfortunately, there were only a few hundred such men in the country. Those plants which needed them most, usually got them. The others are still dependent on the past experience of their personnel and on luck to guide them in the future.

Once given the authority, as well as the responsibility, the welding engineer in charge could begin a cleanup of the bad welding practices in which most plants abound. One of his first problems to overcome was bad welding technique.

Incorrect procedure has been one of the most flagrant errors in modern arc welding. Factories have been known to buy the very best in equipment and then use an electrode several sizes too small, requiring up to 300 per cent more welding time, or to make a series of welds on one joint in the wrong sequence, causing hopeless distortion and warping. As a result, more time is spent in straightening than is spent in welding. Correct procedure can eliminate or greatly reduce this waste of time.

Another source of expensive welding is incorrect welding technique. Most welders have very definite opinions as to the size of rod, angle of the electrode, size of the fillet, for a given weld. Previous to the war, these decisions were generally left to the welder himself. Since the war, however, the labor situation very definitely has taken a turn for the worse. A man (or woman) who can demonstrate that he or she can hold an arc is usually hired on the spot. Obviously, such a class of workmen cannot be left to judge the most efficient technique by themselves. Even at best, a good welder by prewar standards, was not able to judge within ten per cent which combination gave him the minimum spatter, together with maximum speed and penetration and minimum waste of electrode material.

And so both welding procedure and welding technique have been placed under the glass and found wanting as the war began. Fortunately, the welding industry has been able to meet this challenge halfway, and some of those manufacturing plants on which we must depend so greatly for the winning of the war, have placed responsibility for the choice of correct procedure, design, and technique in responsible hands, either the welding engineer or the welding superintendents. Much more of this careful assignment of responsibility, however, is still needed.

Of all the factors entering into an arc weld, none has been surrounded with so much mystery and hokum as the electrodes. In the years preceding the war, most welding rods were sold on a friendship basis. Welding was truly a salesman's paradise. Once the welders and welding foremen were "sold" on the merits of a certain rod salesman, they were immediately "sold" on the electrodes he handled. Everyone and his proverbial brother seemed to be selling rods; yet there were only about 12 large electrode makers. It was not so long ago that many buyers discovered that the only real difference between salesman *A*'s rod and salesman *B*'s rod was that the coating was red instead of green. They both were made in the same electrode plant.

Fortunately, there were a few excellent rods, notably those used for high-pressure boiler work, but most of the rod manufacturers were doing their testing in the customer's plants. When stainless steels started coming into the picture prominently about 1935, it was evident that a tremendous amount of research must be done to manufacture satisfactory stainless electrodes. Coatings on such wires as 25–12 stainless had to be good. Many of the electrode manufacturers realized their responsibility and installed complete metallurgical laboratories for research on future requirements and improvement of their present products.

Such was the picture when war struck home to all of us here in America. Three days after Pearl Harbor the Army tested and passed the first welded armor plate for all-welded tanks. Those first plates were welded with stainless electrodes—incidentally, the same type that only a year or two previously had been developed for use on kitchen equipment and store window fronts.

That was less than a year and a half ago. Yet when Field Marshall Rommel began his retreat in February, destined to be the longest retreat in history, he was retreating in the face of American heavy tanks—all-welded, made only a few months previous. Nothing the Germans could make was a match for the combination of heavy tanks and tank busters, both made from chromium-alloy all-welded armor plate.

The battle for supremacy on the desert was the real proving ground for welded armor plate, and you can be sure it was followed just as closely by the electrode manufacturers as it was by the War Department in Washington. Here truly, welding was winning the war for the United Nations. It might have been a different story if arc welding had remained in the background just a few years longer. Armor welding had not been without its headaches—the biggest one the matter of supply. The unprecedented use of stainless electrodes led to all kinds of problems. Armor plate contains little other than chromium in any quantities, and theoretically, a rod with similar or slightly higher chromium content should do the job. Such was not the case. Invariably, the weld would crack on test. As it stands today, after a year and a half, nearly all armor plate is still being welded with an 18–8 stainless alloy very similar to that used in original tests. In order to reduce the different types of core wire required, many manufacturers are adding some minor alloys, such as molybdenum or manganese as a powder to the coating, so that they will modify the weld metals.

War's greatest effect on electrode manufacture was the unprecedented demand for welding rods of all types.

In 1939 America bought 150,000,000 pounds of electrodes. In 1942 America made an estimated 750,000,000 pounds. The figure will be close to 500,000 tons in 1943. Electrode manufacturers were backlogged several months. Deliveries were averaging three months or more on the more common rods. In order to relieve this problem, the War Production Board ordered many rod makers to discontinue odd sizes and types. Two sizes in particular are practically off the market—$^1/_{32}$ inch and $^7/_{32}$ inch.

Another very important step was the development by one manufacturer of an electrode suitable for vertical and overhead work on high-pressure boiler work for use with a-c machines. This development eliminated one of the few important advantages which d-c welding had held over competitive a-c welding equipment. Many manufacturers are working on similar rods made from stainless and other alloys which are still more or less closed to a-c welding.

A vigorous campaign has been under way for several months to make the best use of the electrodes that are available. Correct technique cited before has helped considerably. Usage of the full rod length is also an important point. One source estimates that several cargo ships could be built every month with the electrodes saved in using all but $1^1/_4$ inches of the electrode instead of the customary two-inch stub.

Thus the war has made the welding industry definitely electrode-conscious. Progress in welding rods is now in the hands of the metallurgists and out of the hands of salesmen.

The third big variable in welding is the equipment used. Of the three fields involved, the electrical industry had done the best job of providing machines with which to work.

Equipment breaks down into three classes quite easily: automatic equipment, d-c equipment, and a-c equipment.

Before the war automatic equipment was considered suitable only for large plants. It quickly became obvious that shipbuilding could be speeded up greatly if one-inch plates could be butt-welded in one pass instead of five, and if this single pass could be made automatically. Shipyards were quick to realize these advantages, and automatic equipment spread like wildfire throughout the industry.

Most automatic equipment was used with a-c welding transformers; the average unit furnishing about 1,000 amperes.

Long before Pearl Harbor an excellent line of d-c motor-generators had been developed by the various manufacturers. This type of machine had been the standard welder for many years, and, through constant improvement, had reached a high degree of efficiency and durability. The war brought few changes in this field.

As a direct result of the need for stainless-steel welding in lighter gauges, one manufacturer placed on the market a small electronic type of d-c welder. This unit, made for precision welding, made possible the production welding of stainless and other hard-to-weld alloys on material down to 30- and 32-gauge using $^3/_{64}$-inch electrodes. An electronic welder, because of its very quick voltage recovery, is ideally suited to low-current welding.

Crater eliminators or remote-control units were developed as a direct result of the use of arc welding in the aircraft industry. Such devices, operated by the welders' hands or feet enabled him to change current values at will, even during the course of the weld. Their use was limited to d-c machines.

Previous to 1936, a-c welding had been something "good to be against" as many welders put it. Early manufacturers placed transformer welders on the market with little regard for life or limb of the user. Open-circuit voltages as high as 100 volts from electrode holder to ground were common. Occasionally some welder would lose his life, and the news spread fast that a-c welding had killed another man. A-c welding needed heavily coated electrodes, needed them badly if it was to survive. Gradually such electrodes were made available. When these electrodes were used the striking voltage could be reduced to 80 volts or lower, especially at higher amperages. Although much of this early prejudice remains even today, a-c welders comprise a large part of new equipment installations.

Previous to the war, most a-c transformers varied output current by means of a tapped secondary winding or tapped series reactor, or combination of both. The continuously variable welders were quite bulky and were subject to considerable wear on the moving parts.

The war gave manufacturers the impetus to improve their a-c welders. Industrial users, in general, demanded continuously variable equipment, and several types of transformer welder circuits were made available. Re-

cently one manufacturer placed on the market a continuously variable transformer and reactor combination giving a higher open-circuit voltage at the lower amperages which reduces to a lower voltage as the current is increased. This reduced the reactive drop and the resultant power-factor correction involved.

In general, then, electrical equipment is of a high quality. A-c welding, in particular, has expanded greatly because of wartime demands, and every evidence points to still greater utilization of this method.

In going over these present-day trends in the three big factors in arc welding today, we have tried particularly to view them in the light of what we can expect in the future. While the war has undoubtedly forced the arc-welding industry to purge itself of many bad practices, the goal is by no means won. The opportunities presented by arc welding are so vast that we have but scratched the surface. In the days that follow the war, shipbuilding may drop off, but for every one less ship to be welded, there will be a dozen cargo planes, or autos, or prefabricated homes, or pieces of farm equipment to take its place. Outside of the United States, Britain, and Germany, arc welding is practically unknown. The world is hungry for men to build the machines, to form the rods, and to teach the science of arc welding. They will look to America for leadership. Can anyone, realizing this, consider for a moment that welding has reached its limit?

Yes, we need men, welding needs good men, good engineers. For every welding engineer in industry today, at least ten are needed. There are years of research ahead. Only a minimum of the many variables have been standardized. Years of research and hard work lie ahead before we can consider our job done.

And as each new alloy is developed, a corresponding development must take place to provide suitable welding electrodes. There is still practically no real standardization in the electrode field.

As better automatic equipment is made available, power supplies must be furnished to match it. High-frequency arc striking, elimination of the hazard to the operator, higher arc efficiency, greatly reduced weights of welders, are but a few of the improvements needed.

Arc welding has given us some of the best fighting equipment in the world, and it has given it to us faster than anything in history. When peace comes again some day, those same hands that welded tanks and guns and ships will weld our homes, our planes, and our future.

Regional Development Through Industrial Research

LAWRENCE W. BASS

Widespread adoption of technical research is recommended as a vital part of the advance planning necessary to the conversion of industrial resources from wartime to peacetime production.

APPLIED SCIENCE has become a major force in our national and regional development during the past century. Its benefits have been most apparent within the last few decades, with the rise of industrial research. It is not a magic panacea for economic ills, but it is a vital part of any constructive program to prevent or cure them. A country, a region, an industry, or a company which does not take advantage of scientific progress is at best doomed to a disappointing future.

In a section in which there are numerous enterprises of medium and small size, such as New England, the technical programs of many concerns necessarily will be on a less grand scale than among some of our large corporations. Such activities may not conform to a classical definition of research, but they must be present to some degree if the work of scientists and engineers is to bear fruit in the form of new or improved products and novel or better processes.

A helpful concept in understanding the place of research in industry is found in the eight "M's" of successful business, adopted as an editorial philosophy by *Chemical and Metallurgical Engineering*. The four basic requirements are materials, methods, machinery, and motive power. To bring them into action, men and money must be provided. These six "M's" are co-

Abstract of an address presented at the AIEE North Eastern District technical meeting, Pittsfield, Mass., April 8, 1943.

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ordinated by management, which directs them to the final goal, markets.

The technical man's influence should, of course, be felt throughout the cycle of production. But the opportunity for systematic study, or research, is most apparent in determining the suitability of materials, in developing satisfactory methods, in designing the necessary new machinery, and in adapting the required motive power, so that improved products demanded by the markets can be fabricated. In this way the framework of an industrial structure is erected by which management can profitably guide the productive capacity of men and of money to fruitful ends.

The technical work necessary to maintain industrial activity at optimum levels may be divided into four general headings, which cannot be sharply differentiated. First is *fundamental research*, aimed at the discovery of basic knowledge. This is carried out for the most part in our educational and scientific institutions, but should be sustained on a still greater scale, with more emphasis on regional resources and with sympathetic co-operation from industry in selecting the most promising fields. Secondly, there is *applied research*, directed at the translation of basic information into practical channels. This should be supported by manufacturers to the limit of their ability. Next comes *engineering development*, the implementation of applied research on a commercial scale. Finally, *production control*, involving technical guidance of manufacturing operations, deserves much more attention from industry to insure maximum efficiency in procedures.

In order that these four types of technical activities may be carried out most constructively, the engineer and the scientist must rise to new heights. Their training must not stop at graduation, but they must be given facilities for continued professional improvement throughout their careers. Scientific societies can do much to encourage study groups by means of local and regional programs. Libraries, both public and private, should be stimulated to expand their collections and services. More attention should be given in professional circles to questions of broad economic importance, and the interchange of ideas and philosophies with business executives should be fostered.

There is no royal road by which scientists and engineers can reach a solution of the problems of wartime or of the postwar period. The real answer lies in the adoption of a twofold program—individual initiative on the part of both technical men and management, and the concerted efforts of professional groups toward regional development. To effect the former, every company executive should strive to secure the best possible sources of scientific and engineering knowledge, and every technical man should broaden his vision and seek means by which he can contribute to the general welfare of his community and region. To institute the latter, professional organizations and industry have the reciprocal responsibility of providing a stimulus for and of supporting a universally aggressive technology.

In order that scientists and engineers may best aid in efforts toward regional development, some form of organization is desirable. Committees representing a range of professional groups have been used effectively, normally with subcommittees in special fields to insure widespread participation. It is advantageous to include the social sciences in setting up such boards. Careful thought should be given to the size of the community or district to be included; too narrow a scope may stifle the effort.

An industrial development committee, as it might be called, can be active on both short- and long-range projects. The former, which have the encouraging effect of rapid results, include service as a clearing house for technical information, assistance in finding professional personnel, advice on methods of attacking specific problems, and the encouragement of educational talks before nontechnical audiences. The more elaborate type of undertaking, which imparts depth and permanence to the program, is represented by studies of local resources and industrial facilities, stimulation of pertinent fundamental researches, co-operation in educational policies, and assistance to libraries.

The establishment of committees is, of course, only the initial stage, and the small number of opportunities for service during the early months of the organizations is likely to be discouraging. However, in such an instance, the newly established committee can often profit greatly by a more or less close association with other public service groups. Through judicious publicity, attention and support can be drawn to long-range undertakings and business men can be reminded of the existence of an organization to which they should turn in time of need.

The technical man is not usually endowed with marked gifts in the direction of public relations and contacts. The business man who has had little contact with the professional world tends to expect the impossible, and does not realize that one of the most valuable contributions such a group can make toward solving his difficulties is advice on how he can take steps to help himself. The success of an industrial development committee depends upon the harmonious working together of these complementary business personalities.

The nonprofit Foundation with which I am connected was set up as a practical step toward regional improvement. Our objectives are broad: to aid companies in planning and organizing research programs; to encourage critical surveys of natural resources; to stimulate basic investigations that will provide foundations for new industries; to co-operate with any groups that foster contacts between scientists and business executives; and to serve as a clearing house for information on these subjects. In short, we are doing all we can to help industry to use one of our greatest regional resources—the technical man.

International Standardization

L. F. ADAMS
FELLOW AIEE

A brief historical review of two of the existing international standards-making bodies of chief concern to the electrical industry.

IN THESE DAYS international standardization is all but forgotten. Nevertheless, we are giving increased attention to our present and future business relations with South American countries, which are becoming standards-conscious, and after the war renewed activity in standardization on an international scale may be expected. Although one cannot, or should not, predict the developments or exact course such standardization will take, it is reasonable to assume that it will be built upon existing organizations and present accomplishments. Therefore, a brief historical review of two of the international standards-making bodies that are of chief concern to the electrical industry may be of interest. These two organizations are the International Electrotechnical Commission and the International Standards Association. Other organizations, such as the World Power Conference, the International High-Voltage Conference and the International Commission on Illumination serve as engineering forums, and may reveal the need of and produce technical information pertinent to standards, but they do not establish standards.

In September 1904, the chamber of government delegates met during the International Electrical Congress of St. Louis, Mo., and passed a resolution "that steps should be taken to secure the co-operation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardization of the nomenclature and ratings of electrical apparatus and machinery." As a result of this, and shortly thereafter, the International Electrotechnical Commission was formed, with headquarters in London, England.

Any country may join the IEC upon request by forming a national committee through its technical societies or national standardizing body. For many years, the IEC work in the United States has cleared through the United States national committee of the IEC which was established originally by the AIEE. Upon formation of the electrical standards committee of the American Standards Association in 1931 the two committees were made almost identical. Thereby, close co-operation between national and international standardization in the electrical field was effected.

As was inevitable, the IEC became inactive shortly following the outbreak of hostilities in 1939. At that time it had as members 27 countries, three of which belong to the Western Hemisphere—Argentina, Canada, and the United States. In February 1941, I had a letter from C. le Maistre, director of the IEC, telling that the Commission's offices had suffered rather badly from enemy bombing and that some of the stock of publications was destroyed. However, records and some office equipment had been removed from London and were intact, according to latest information.

The IEC Standards that have been produced amount to some dozen and a half in number. Several of these are of fundamental importance and have done much to unify electrical practice internationally, such as the International Standard of Resistance for Copper. The IEC also co-operates with other international bodies, particularly the International Union of Pure and Applied Physics and the International Bureau of Weights and Measures, in standardizing electrical units. These are of the greatest fundamental importance as they provide an electrical language, so to speak, which is universal. The principal basic electrical units had been established, prior to formation of the IEC through the International Electrical Congress.

Other Standards deal with specific subjects, such as the IEC Specification for Electrical Machinery, covering both rotating machines and transformers, which comprise the scopes of two ASA projects. Such IEC Standards are general and engineering in character, corresponding approximately in contents to the AIEE Standards on these subjects as they existed some 20 years ago.

Since the AIEE Standards existed prior to other electrical standards, they served as a basis for much of the early IEC work—hence the close agreement which existed between IEC recommendations and AIEE Standards. As standardization becomes more detailed, it is increasingly difficult to maintain this agreement. Considering the difficulty with which agreement is sometimes reached on standards in a single country in resolving different opinions in the industry, one can appreciate that standardization between countries is more tedious and must of necessity be confined more closely to fundamental requirements.

Although in international trade electrical equipment is sometimes specified to be in accordance with IEC recommendations, probably the most good has been accomplished by drawing together the standards of the various countries.

The publications of the IEC in the past have variously

Conference paper presented at the AIEE summer technical meeting, Cleveland, Ohio, June 21–25, 1943.

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been known as Standards, Specifications, Rules, and so forth, but lately the IEC has agreed to call them Recommendations. An understanding has been reached in the Commission as to the status and extent these Recommendations are binding on the national committees of the various countries. In brief it is that:

"The formal decisions or agreements of the IEC on technical matters . . . express as nearly as possible an international consensus of opinion on the subjects dealt with. They have the force of recommendations for international use and they are accepted by the national committees in that sense. The desirability is recognized of extending international accord on these matters through an endeavor to harmonize national standardization rules and these recommendations in so far as national conditions will permit. The national committees pledge their influence toward that end."

The work of the IEC is subdivided among about 30 advisory committees. It has been customary to have a general get-together, called a plenary meeting, of all of these advisory committees about once every three years, but hardly a year passes, except for the war periods, when there has not been a meeting of some of the advisory committees.

The International Standards Association is a federation of 20 national standardizing bodies, each of which is the central clearing house for industrial standardization work in its own country. The purpose of the ISA is the systematic exchange of information on standardization work accomplished or in course of development in the different countries, and the promotion of uniformity among the various national standards, wherever this appears to be feasible and desirable.

The basis for the ISA was laid at an international conference held in New York, N. Y., in 1926. The ASA joined the ISA in the fall of 1929. The central office of the ISA is located in Basle, Switzerland.

Because of the war, ISA activities have ceased and the small headquarters staff has been dissolved. Records have been transferred to the Swiss national standardizing body for safekeeping.

The project work of the ISA is done by technical committees on which each member country has the right to be represented. The final report of a technical committee serves as a recommendation to all countries in establishing their national standards. Acceptance of such a recommendation is entirely voluntary.

Although the name of this association implies an all-inclusive scope, it has dealt mainly with mechanical subjects. However, it has on its slate a few subjects, such as acoustics, petroleum, paper sizes, and photography. None of its projects overlaps IEC work although some of the subjects, such as center heights of shafts, shaft extensions, shaft couplings, and pulleys, would be applicable to electric machines.

Safety Engineering in the Technical College

A. NAETER
MEMBER AIEE

On the theory that employers look with favor upon prospective employees who list among their qualifications training in safety engineering, The Oklahoma Agricultural and Mechanical College has been conducting a successful course in this field for several years.

ONE of the few courses in safety-engineering given in the United States is that which the Oklahoma Agricultural and Mechanical College has offered for some years past. Over ten years ago Colonel Philip S. Donnell, dean of engineering, now overseas on active military duty, appointed an engineering-faculty committee on first aid to study the problem of suitable instruction for graduating seniors in all departments of engineering. As a result, a required course of instruction in first aid was introduced in 1932 for all senior engineering students. Since so many engineering graduates regularly entered the oil industry, one of the major mining industries, the United States Bureau of Mines instructed their senior first-aid instructor at the Bureau of Mines station in McAlester to give the work.

This work consisted of five three-hour periods of instruction, covering such topics as the need of first-aid instruction, bleeding and pressure points, fractures and splinting, bandaging, heatstroke and sunstroke treatment. Particular emphasis was placed on the Schaeffer prone-pressure method of artificial respiration. Immediately favorable response came from practically all of the students. They were aware of the fact that the instructor had the saving of over 200 lives to his credit and, hence, could speak with authority. The work was offered to groups of 30 or 40 students.

A. Naeter is head of the electrical-engineering department of the Oklahoma Agricultural and Mechanical College, Stillwater, Okla., and has been a member of its engineering first-aid committee since its establishment in 1932.

The author acknowledges the assistance of E. R. Stapley, acting dean; H. G. Thuesen, acting assistant dean; DeWitt Hunt, campus-safety-committee chairman; H. W. Orr, physiology professor; Fire Chief Pence; and J. B. Hynal of the United States Bureau of Mines, first-aid instructor.

Essential substance of a conference paper presented at the AIEE South West District technical meeting, Kansas City, Mo., April 28–30, 1943, and at the AIEE summer technical meeting, Cleveland, Ohio, June 21–25, 1943.

This course of instruction was given and still is being given during each spring semester. During the periods of instruction, this work takes precedence over all conflicting laboratory work.

Students are encouraged to notify their college engineering departments after leaving school when they have the opportunities to give first-aid treatment. During the first four years, at least four cases of life saving through artificial respiration were reported. Numerous cases of splinting and bandaging fractures, stopping bleeding, and the like have come to the attention of various representatives of the college.

After a few years of offering only first-aid instruction, it was felt that the time had come for safety-engineering instruction. Once a man had had a tourniquet on his arm, he would be aware much more acutely of the great desirability of avoiding the need of so drastic a treatment. That feeling would lead naturally into the field of accident prevention.

In 1936 a one-semester-credit course of instruction required for graduating seniors was introduced. The course, as outlined, consisted of three parts:

(*a*). Physiology and industrial hygiene, six or seven lectures given by a biologist speaking from the industrial angle.

(*b*). Safety-engineering and accident prevention work, five or six lectures on methods used in the fields of safety engineering, as practiced in industry.

(*c*). First aid, given by either a Bureau of Mines representative or a representative of the Red Cross.

During past years the physiology and industrial hygiene lectures have been given by a professor of physiology on the college faculty. These lectures deal with such topics as the structure of bones and joints, the blood, the heart, the lymphatic system. The discussion of the blood, for example, deals with its characteristics, blood plasma, coagulation, and the conditions necessary for it. The instructor is very successful in using engineering illustrations rather frequently. His comparisons between the lymphatic system of the body and the sanitary system of a city are interesting. At various times these lectures are supplemented by suitable motion pictures.

The safety-engineering portion of the course has varied, depending on the availability of suitable speakers. At different times the Petroleum Safety Council in Tulsa has arranged lecture series covering suitable topics presented by experienced safety engineers and others. In the spring of 1937 this series contained lectures on these topics:

1. Why Compensation Laws and Accident Prevention are Necessary.
2. The Supervisor's Responsibility.
3. Explosion Hazards.
4. Engineering Standards.
5. Explosives—Their Safe Use.
6. Transportation Problems.
7. Accident Analysis and Remedial Measures.

The series given in the fall of 1937 contained a new topic under the title, "Fire-Prevention Engineering." In March 1943, a major company sent its first-aid specialist to speak to the class. He brought along the company ambulance and much illustrative material. At times demonstration lectures are given by representatives of first-aid supply companies.

A lecture on the safe operation of motor vehicles was introduced as follows: "I believe, in order to obtain co-operation in safe operation of motor vehicles on our streets and highways, we must first give the people a picture of our present motor-vehicle problem, its development, the terrible annual toll it is exacting, and an intelligent, practical, well-planned program of adequate control based on years of experience, study, and research by traffic experts throughout the country. It should then be comparatively easy for intelligent sane operators of motor vehicles to realize how important it is, for their own protection as well as the lives and property of others." After analyzing the problem and the contributing causes, the solution was discussed under the headings of education of school and adult groups, engineering as applied to standardization and to building safety into streets and highways, and definite, practical, and reasonable policies of enforcement.

Since the AIEE is interested particularly in electrical problems, attention should be called to a talk dealing with practical safety methods applied to line construction. Proper job planning reduces the chance of accident and expedites the work. The choice and placement of men depends on physical fitness, experience, and mental ability and alertness. Emphasis must be placed on the proper selection, inspection, and maintenance of hand tools and mechanical equipment. The proper supervision of the employees involves safety instructions, use of bulletin boards, and follow-up by foreman and subforeman.

CAMPUS SAFETY-CONSCIOUS

Very definite efforts are being made continuously to make and keep the students and faculty safety-conscious. A campus safety committee, with a majority representation from the engineering faculty, is very active. Particular attention is paid to traffic hazards. A heavy traffic highway has been rerouted to miss the campus by over one half of a mile. Policemen are on duty at key street intersections when classes change. Since troop units have come to the college for instruction, some of the heavy traffic streets on the campus have been closed permanently and others declared military highways.

The campus safety committee has been unusually successful in keeping accidents at a very low level in shop and laboratory. It makes extensive use of National Safety Council posters and other similar material.

Laboratory and other campus facilities are subject to inspection upon request, as well as at unannounced intervals, by the Oklahoma Bureau of Factory Inspec-

tion–Accident Prevention. Its recommendations and requirements must be carried out within specified time intervals, and more serious hazards are eliminated immediately, even though doing so should involve shutting down a place where students or faculty or campus employees work.

One of the Stillwater fire stations is located on the campus. It serves both as a fire station for the campus and a part of town, as well as a laboratory for the only collegiate firemanship training school in the United States. It pays particular attention to matters involving fires and their dangers in town and on the campus.

CONCLUSION

These various safety elements have been listed to indicate a setting into which safety-engineering instruction fits very well. This work has been carried on for a time sufficiently long to put it well beyond the experimental stage.

In the time between the first World War and the present global war, increasing emphasis was placed on the importance of safety engineering in all of its ramifications. The requirements of the present war have brought it to the very forefront.

From the very beginning of the program it was recognized that employers look with favor upon prospective employees who list among their qualifications training in the basic elements of safety engineering as well as the possession of a first-aid certificate.

REFERENCE

Safety Engineering Training a Graduation Requirement, A. Naeter. *The Journal of Engineering Education*, volume XXXII, number 10, June 1942.

The Horsepower Meter for Aircraft

J. C. LUTTRELL
NONMEMBER AIEE

W. A. PETRASEK
ASSOCIATE AIEE

The torquemeter method of operating aircraft engines was developed to meet the need for more accurate engine control and to help ease the work of the pilot. The horsepower meter described herein was developed to provide suitable and accurate instrumentation for that method.

THE EVER INCREASING magnitudes of engine-horsepower ratings and the accompanying augmented fuel consumption has thrown the spotlight on improved methods of aircraft-engine operation. The existing method of "chart-horsepower" operation has been analyzed and found basically too inaccurate to warrant further refinement of the associated instrumentation. The development of the torquemeter-equipped engine bears witness to the need for more accurate engine control.

Airplane-engine control may be simplified by the use of a direct-reading brake-horsepower meter. Furthermore, the technique of the brake-horsepower meter, as described in this article, in combining electrically the torque output with engine speed, makes possible an increase in the accuracy of the instrumentation. With a suitable direct-reading brake-horsepower meter, it would be necessary only for the pilot to set the horsepower and revolutions per minute, and lean the engine gasoline–air mixture to the minimum allowable. No empirical "charts" would have to be consulted nor corrections for altitude and temperature made. Furthermore, inasmuch as the horsepower being measured is that actually delivered by the engine, all the incalculable factors affecting engine horsepower are no longer of any consequence to the pilot, who is interested solely in the power being developed at the propeller. The elimination of the tachometer reading, with its one per cent error, is realized. This is particularly true of the horsepower meter in conjunction with a-c tachometer installations of the frequency type (see Figure 2).

The basic circuit necessary to combine electrically the torque output of an engine with the engine speed in order to calculate brake horsepower is broadly old, patents having been issued for horsepower circuits prior to the beginning of the present century. The circuit in Figure 1 shows how the fundamental electrical equation, $I=E/R$, is adapted to an aircraft engine installation.

The pressure from the torquemeter of the engine varies a resistance inversely with the pressure, this resistance being connected in series with the engine tachometer generator and an ammeter which is calibrated to read in units of brake horsepower. This combination is electrically sound, but its practicability is limited from a maintenance standpoint because the variable resistance,

J. C. Luttrell is with the Army Air Force Transport Command, Washington, D. C., and **W. A. Petrasek** is project engineer, American Airlines, Inc., La Guardia Airport, New York, N. Y.

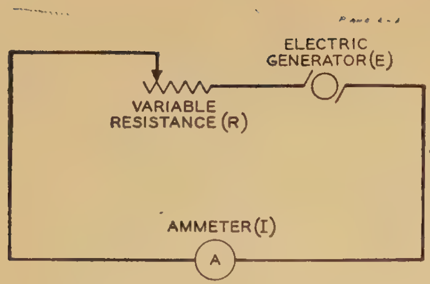


Figure 1. D-c horsepower-meter circuit

Brake-horsepower equation for engines with torquemeter attachments:

$$\frac{\text{Torque pressure} \times \text{rpm}}{\text{Constant}} = \text{brake horsepower} \tag{1}$$

Equation for the electric circuit shown:

$$I = \frac{E}{R} \tag{2}$$

In this circuit, E is directly proportional to rpm, R varies inversely with the torque pressure. Therefore,

$$E \sim \text{rpm and } R \sim \frac{1}{\text{torque pressure}} \tag{3}$$

Substitute relationships (3) in (2):

$$\left.\begin{aligned} I &= \frac{E}{R} = \frac{\text{rpm}}{\dfrac{1}{\text{torque pressure}}} = \frac{\text{rpm} \times \text{torque pressure}}{1 \ (\text{or } K)} \\ \text{Therefore } I &= \frac{\text{rpm} \times \text{torque pressure}}{K} = \text{brake horsepower} \end{aligned}\right\} \tag{4}$$

tachometer generator, and ammeter have to be calibrated as a unit, making it impossible to change any one of the units on an airplane in a field without affecting the accuracy of the meter. The limitations of this type of horsepower meter may be compared with the limitations of the d-c tachometer installation which depends upon the voltage stability of a magneto for its accuracy.

The preferred a-c brake-horsepower meter is shown in Figure 2. A typical two- or three-phase a-c tachometer is installed. The output of any two of the existing tachometer-generator wires is connected across the terminals of a saturated-core transformer. The output of the transformer is applied to the fixed whole resistance of a potentiometer, the movable contact of which is controlled by engine torque. This potentiometer-control device is preferably of the type which develops torque right up to the control point.

The operation of the meter is as follows: The output frequency of the tachometer generator varies proportionately with engine speed. This proportional variation of frequency is transformed into a proportional voltage variation with speed by the saturated-core transformer which is relatively undisturbed by small changes in generator output voltage. This fact alone makes it possible to replace tachometer generators without having to recalibrate the horsepower meter, and permits the interchangeable use of various existing tachometer generators. The voltage variation which is proportional to engine speed is impressed across a potentiometer resistance, and a specific ratio of this voltage is impressed across an a-c voltmeter suitably calibrated in brake horsepower. This voltage ratio is determined by an electric motor-driven control unit which varies the potentiometer output resistance proportionately to engine torque. The resultant voltage measured on the indicator is proportional to both the potentiometer input-voltage variation as well as to the variation of the resistance ratio, and, hence, it is proportional to their product or brake horsepower. The wires shown by dotted lines in Figure 2 may be omitted in the installation provided the equipment is appropriately grounded as shown. It is seen that only one additional wire from the engine to the instrument panel is necessary for the installation of a brake-horsepower-meter indicator. The electric power leads for the torque-motor unit may be obtained from any convenient source of power in the engine nacelle, and will, at most, require only a short length of wire.

An analysis of the possible accuracy of the foregoing combination indicates that an over-all maximum error of approximately three per cent is feasible. No error is incurred in the engine-speed conversion to frequency. An error of 0.5 per cent can be maintained in the conversion from frequency to voltage in the saturated-core transformer. An error of 1.5 per cent can be allocated to the torque-varied potentiometer, and the indicator voltmeter limited to an error of one per cent. The total error is considered tolerable in view of the fact that the scale calibration of a standard aircraft indicator, having a 270-degree pointer movement, will not permit the reading of the instrument beyond an accuracy greater than three per cent.

The following is a summary of some of the more important advantages of the horsepower meter as described in this article:

1. It makes increased accuracy of engine control possible. Horsepower determination within three per cent is possible.
2. It provides a continuous check on engine operation, and makes possible the detection of leaky valves and ignition trouble through the reflection of a loss in engine-horsepower output.
3. It provides an immediate confirmation of takeoff power under all conditions of operation.
4. It provides a simple means of instrumentation for torquemeter operation of engines in the light of existing instrumentation limitations.

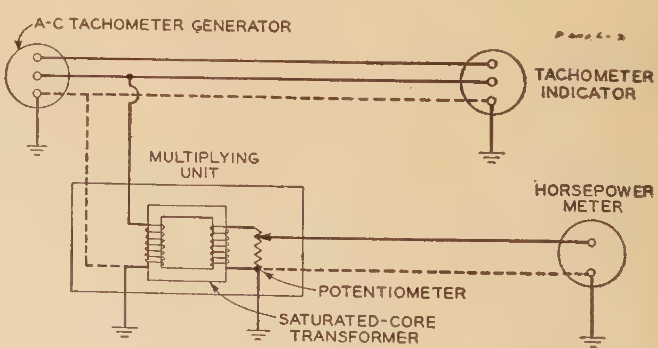


Figure 2. A-c horsepower-meter circuit

INSTITUTE ACTIVITIES

AIEE Officers to Be Nominated for 1944 Election

For the nomination of national officers to be voted upon in the spring of 1944, the AIEE national nominating committee will meet during the winter technical meeting, New York, N. Y., January 24–28, 1944. The officers to be elected are: a president, a national treasurer, three directors, and five vice-presidents, one from each of the odd-numbered geographical Districts. Fellows only are eligible for the office of president, and Members and Fellows for the offices of vice-president, director, and national treasurer.

To guide this committee in performing its constituted task, suggestions from the membership are, of course, highly desirable. To be available for the consideration of the committee, all such suggestions must be received by the secretary of the committee at Institute headquarters, not later than December 15, 1943.

In accordance with the provisions in the constitution and bylaws, as amended during 1935 and quoted in the following paragraphs, actions relative to the organization of the national nominating committee are now under way.

Constitution

28. There shall be constituted each year a national nominating committee consisting of one representative of each geographical District, elected by its executive committee, and other members chosen by and from the board of directors not exceeding in number the number of geographical Districts; all to be selected when and as provided in the bylaws. The national secretary of the Institute shall be the secretary of the national nominating committee, without voting power.

29. The executive committee of each geographical District shall act as a nominating committee of the candidate for election as vice-president of that District, or for filling a vacancy in such office for an unexpired term, whenever a vacancy occurs.

30. The national nominating committee shall receive such suggestions and proposals as any member or group of members may desire to offer, such suggestions being sent to the secretary of the committee.

The national nominating committee shall name on or before January 31 of each year, one or more candidates for president, national treasurer, and the proper number of directors, and shall include in its ticket such candidates for vice-presidents as have been named by the nominating committees of the respective geographical Districts, if received by the national nominating committee when and as provided in the bylaws; otherwise the national nominating committee shall nominate one or more candidates for vice-president(s) from the District(s) concerned.

Bylaws

Sec. 22. During September of each year, the secretary of the national nominating committee shall notify the chairman of the executive committee of each geographical District that by December 15 of that year the executive committee of each district must select a member of that District to serve as a member of the national nominating committee, and shall by December 15, notify the secretary of the national nominating committee of the name of the member selected.

During September of each year, the secretary of the national nominating committee shall notify the chairman of the executive committee of each geographical district in which there is or will be during the year a vacancy in the office of vice-president, that by December 15 of that year a nomination for a vice-president from that District, made by the District executive committee, must be in the hands of the secretary of the national nominating committee.

Between October 1 and December 15 of each year, the board of directors shall choose 5 of its members to serve on the national nominating committee and shall notify the secretary of that committee of the names so selected, and shall also notify the 5 members selected.

The secretary of the national nominating committee shall give the 15 members so selected not less than 10 days' notice of the first meeting of the committee, which shall be held not later than January 31. At this meeting, the committee shall elect a chairman and shall proceed to make up a ticket of nominees for the offices to be filled at the next election. All suggestions to be considered by the national nominating committee must be received by the secretary of the committee by December 15. The nominations as made by the national nominating committee shall be published in the March issue of *Electrical Engineering* (Journal of AIEE), or otherwise mailed to the Institute membership not later than the first week in March.

INDEPENDENT NOMINATIONS

Independent nominations may be made in accordance with provisions in article VI, section 31, of the constitution and section 23 of the bylaws, which are quoted below:

Constitution

31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the national secretary when and as provided in the bylaws; such petitions for the nomination of vice-presidents shall be signed only by members within the District concerned.

Bylaws

Sec. 23. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with article VI, section 31 (constitution), must be received by the secretary of the national nominating committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the national nominating committee in accordance with article VI of the constitution and sent by the national secretary to all qualified voters during the first week in April of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

(*Signed*) H. H. Henline,
National Secretary

November 1, 1943

Future AIEE Meetings

Southern District Meeting
Roanoke, Va., November 16–18, 1943

Winter Technical Meeting
New York, N. Y., January 24–28, 1944

North Eastern District Meeting
Boston, Mass., April 1944

Summer Technical Meeting
St. Louis, Mo., June 26–30, 1944

North Eastern District Executive Committee Meets

The executive committee of the North Eastern District held its fall meeting in Schenectady, N. Y., October 8, 1943, with 100 per cent representation of Sections.

The meeting was addressed by W. F. Cotter (M '28), District vice-chairman of the AIEE committee on membership, who spoke on the activities of that committee and mentioned a plan to send a letter to each Section outlining the work expected of it in improving or sustaining membership. The general discussion following his talk brought out specific practices of the Sections represented. The Boston Section, which has as chairman of its membership committee one experienced in its work, endeavors to have a representative wherever there are four or more engineers. This Section also noted that changing its meeting place to one easy of access by public transportation improved attendance. Advance planning of the year's meetings is employed by several Sections as a means of attracting and sustaining membership. Publicity and membership activity is combined by the Rochester Section.

In this connection H. H. Henline (F '43) national secretary, speaking on Institute activities in general, stated that many Sections were experimenting with both geographic and technical subsections. The experience of the New York Section seems to indicate that attendance at the technical meetings overshadows that at the general-subject type.

The Connecticut Section has substituted a plan of shifting meeting locations for the alternative of forming subsections. Returning to the subject of meeting topics, the discussion considered orienting of meeting topics toward the war effort. The general opinion was that experience with the recent series on conservation of materials had been disappointing in attendance and interest. Rather than have the Institute headquarters provide speakers on specific subjects, most of the speakers preferred that it continue the list of successful meeting topics. Two Sections announced plans for talks on postwar planning, emphasizing personnel, changes in production, and consequent changes in loads on utilities.

Student Branch activities were discussed by R. G. Porter (M '35), chairman of the District committee on student activities. Despite the fact that wartime conditions have prevented student conventions at District technical meetings, he recommended holding a conference of Branch counselors and chairmen. It was voted to call such a meeting at the 1944 technical meeting. In addition, it was suggested that Professor Porter write to all Branches to stimulate combined activity

of Army and Navy trainees and civilian Branch members.

Other business of the meeting included the voting of a transfer of $500 from the treasury to an interest-bearing Government bond. A report on the Pittsfield District technical meeting was submitted by J. R. Meador (M '40) chairman of the Pittsfield Section (see *Electrical Engineering*, May 1943, pages 216–18). It was voted to accept the invitation of the Boston Section to the District to hold its 1944 technical meeting there in April. In addition Mr. Henline announced that the board of directors is ready to consider invitations for 1945 meeting locations, and the Niagara Frontier Section invited the 1945 District meeting to its territory.

The following appointments were made:

District co-ordinating committee—K. B. McEachron, V. Siegfried, R. G. Porter, M. H. Pratt, H. P. Turner, J. R. Meador, E. C. Brown.

Technical meeting committee—the foregoing seven men plus additional appointees who will be announced later.

Committee on award for best and initial paper prizes—A. G. Conrad, R. W. Ager, F. R. Longley.

C. F. Kettering

J. B. MacNeill

H. S. Warren

PERSONAL • • • •

Charles Franklin Kettering (A '04, F '14) vice-president in charge of research, General Motors Corporation, Detroit, Mich., has been awarded the John Fritz Medal for 1944, "for notable achievements in the field of industrial research which have contributed greatly to the welfare of mankind and of the nation." Doctor Kettering who was born at Loudonville, Ohio, August 29, 1876, was graduated from the course in electrical engineering at Ohio State University in 1904. He has had the honorary degree of doctor of engineering conferred upon him by the University of Michigan, 1929; Ohio State University, 1929; the Polytechnic Institute of Brooklyn, 1930; the University of Detroit, 1934; and holds honorary degrees of doctor of science from the University of Cincinnati, 1928; Brown University, 1932; Toledo University, 1934; Northwestern University, 1935; Lafayette College, 1936; Harvard University, 1939; Dartmouth College, 1939; and Columbia University, 1943. From 1898 to 1900 he was chief engineer for the Star Telephone Company, Ashland, Ohio. As electrical engineer and head of the department of electrical engineering for the National Cash Register Company from 1904 to 1910, he developed the electrically driven cash register and several types of electrical-control-operated accounting and auditing machines. In 1910 he founded the Dayton (Ohio) Engineering Laboratories Company to manufacture electric starting, lighting, and ignition systems which he had invented. In 1916 he established a research laboratory at Dayton which was taken over by the General Motors Corporation in 1920 and moved to Detroit in 1925. Doctor Kettering is the patentee or copatentee of more than 140 patents. He is vice-president of the Frigidaire Corporation and the Delco-Light Company, and a trustee of Antioch College. Recently he was appointed chairman of the advisory committee for Northwestern Technological Institute. In 1933 he was appoin ed to the science advisory board of the National Research Council and in 1942 was appointed consultant to the :adio branch of the War Production Board. Many previous honors have been awarded him including the Sullivant Medal of Ohio State University in 1929, the Washington Award of 1925, the Medal of the Franklin Institute and the John Scott Memorial Award in 1936, the modern pioneer award in 1940, and the Medal of the American Society of Mechanical Engineers in 1941. A fellow of the National Academy of Science, Doctor Kettering is also a member of the Society of Automotive Engineers, the American Society of Mechanical Engineers, the American Society for Testing Materials, American Society for Metals, the American Academy of Social and Political Science, the American Philosophical Society, the American Physical Society, the American Academy of Science, the American Association for the Advancement of Science, the American Society of American Military Engineers, the American Chemical Society, and the Legion of Honor.

J. B. MacNeill (A '18, F '42) manager of engineering, switchgear division, engineering department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been appointed chairman of the AIEE committee on protective devices for 1943–44. Mr. MacNeill served on the committee for 1920–22, again from 1928 to 1932, and recently since 1936. He was born June 21, 1888, in Summerside, P. E. I., and was graduated from the Massachusetts Institute of Technology in 1913 with the degree of bachelor of science in electrical engineering. In 1913 Mr. MacNeill entered the employ of the Westinghouse company as a design engineer in the switchboard department. From 1918 to 1928 he was engineer in charge of the circuit-breaker design section. He was made manager of the circuit-breaker design department in 1931 and general manager of the distribution engineering department in 1933. He was transferred to Boston, Mass., as manager of the New England engineering department in 1933 but returned to East Pittsburgh in 1935 as manager of engineering. Under Mr. MacNeill's supervision 1,500,000-kva indoor powerhouse circuit breakers were developed, and the commercial application of the deion principle was accomplished. Several patents have been issued in his name. A member of the National Electrical Manufacturers Association, he represented that body at the World Power Conference in Berlin, Germany, in 1930. He also served on the AIEE committee on power transmission and distribution from 1933 to 1935.

H. S. Warren (A '03, F '13) consulting electrical engineer, New York, N. Y., has been appointed chairman of the AIEE board of examiners for 1943–44. He has been a member of the board since 1930. Mr. Warren was born in Oldtown, Me., March 3, 1873, and was graduated from Stanford University with the degree of bachelor of arts in 1898. After a year spent in wiring and installation work in the power plants of the Standard Electric Company of California, San Francisco; the California State Board of Harbor Commissioners; and the Nevada County Electric Power Company, Nevada City, Calif.; he joined the American Bell Telephone Company, Boston, Mass., in 1899. Occupied thereafter with telephone transmission developments, he designed the loading coils required for the successful commercial application of open-wire circuits about 1901. Later he designed the coil which permitted the widespread practical operation of phantom circuits. From 1909 to 1919 he was engaged in external relations for the American Telephone company in connection with railroad electrification. In 1919 he became protection development engineer, and after the research department of the American Telephone company was combined with the Bell Telephone Laboratories, Inc., New York, N. Y., in 1933, he was made director of protection development at the laboratories. In 1938 he retired from Bell Laboratories to open his own consulting practice. His Institute committee memberships include: safety codes, 1915–40 (chairman

1935–37); traction and transportation, 1916–17; power transmission and distribution, 1925–41; as well as the electrical committee of the National Fire Protection Association on which he represented the Institute 1935–37, and acted as alternate for 1923–24, and for 1938–43. In 1931 he shared in the national prize award for the best paper in engineering practice for his contribution, "Status of Joint Development and Research on Low-Frequency Induction," to the symposium on co-ordination of power and telephone plant. He is a fellow of the American Association for the Advancement of Science, a member of Sigma Xi, and a past president of the Telephone Society of New England.

John Grotzinger (A '24) chief engineer, electrical engineering department, Goodyear Tire and Rubber Company, Akron, Ohio, has been appointed chairman of the AIEE committee on industrial power applications for 1943–44. Mr. Grotzinger has been a member of the committee since 1939 and was a member of the predecessor committee on general power applications from 1930 to 1934. Born in Schaffhausen, Switzerland, December 22, 1891, he was graduated from Bienne Institute of Technology in Switzerland in 1913. During 1913 he was draftsman for the Canadian Crocker-Wheeler Company, St. Catharines, Ont., and electrician for the Toronto Power Company and the American Cyanamid Company, both of Niagara Falls, Ont. From 1914 to 1917 he was assistant works engineer and works engineer for Electro Metals Ltd., Welland, Ont. He was employed first as engineer in charge of design of plants and then as superintendent of operations by the Pacific Electro Metals Company, San Francisco, Calif., during 1917 and 1918. In 1919 he worked as electrical engineer for the McKinnon Dash Company, Buffalo, N. Y., and in 1920 he joined the Goodyear Tire and Rubber Company as electrical engineer. In 1927 he was appointed chief electrical engineer. In this position he has designed many rubber plant projects both in the United States and abroad. World War II has brought aircraft plants, ordnance plants, and synthetic rubber plants within the scope of his work.

H. E. Wulfing (M '23) system development engineer, Commonwealth Edison Company, Chicago, Ill., has been appointed to the chairmanship of the 1943–44 AIEE committee on power transmission and distribution of which he has been a member since 1936. Born August 20, 1881, in Richland Center, Wis., he received the degree of bachelor of science in electrical engineering from the University of Wisconsin in 1905. Mr. Wulfing commenced his engineering career as a wireman for the Chicago, Rock Island, and Pacific Railroad, Chicago, Ill., in 1905. From 1906 to 1908 he was construction foreman for W. E. Clow and Company, Newcomerstown, Ohio. In 1908 he became testing engineer with the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., and during 1909 and 1910 he worked as appraisal engineer for H. M. Byllesby and Company, Chicago. Joining the Commonwealth Edison Company as superintendent of the outside plant department in 1910, he was transferred to the inside plant division in 1913. Remaining in that division until 1924, he served as engineer of substations and assistant superintendent of overhead lines. In 1924 he was named staff engineer attached to the office of the chief electrical engineer, and in 1933 he became system development engineer. He served on the AIEE committee on power generation for 1936–37 and is currently serving on the committee on award of Institute prizes.

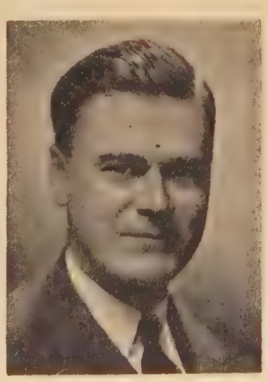
W. N. Zippler (A '20, M '38) chief electrical engineer, Gibbs and Cox, Inc., New York, N. Y., has been appointed chairman of the 1943–44 AIEE committee on marine transportation. He has been a member of this committee and its predecessors since 1929. Mr. Zippler was born March 19, 1896, in Philadelphia, Pa., and received the degrees of bachelor of science in 1920 and electrical engineer in 1932 from the University of Pennsylvania. In 1920 he joined the staff of the construction department of the International Mercantile Marine Company, New York. He remained in this position when the construction department was incorporated as Gibbs Brothers in 1922, and that firm was enlarged to Gibbs and Cox in 1929. In 1940 Mr. Zippler was appointed chief electrical engineer. He has supervised the design and construction of the electrical installation, including electrical propulsion, for many large passenger and cargo vessels, as well as for United States Naval destroyers and for private yachts. He served as electrical consultant in the preparation of *United States Senate Report 184*, which established a safety standard for construction of American passenger vessels after the Morro Castle disaster. In 1939 he acted as alternate for the AIEE representative on the American Standards Association's sectional committee on electrical installations on shipboard. Mr. Zippler is a member of the Society of Naval Architects and Marine Engineers and of Eta Kappa Nu.

G. W. Bower (A '18, M '40) engineer, Public Service Electric and Gas Company, Newark, N. J., has been appointed 1943–44 chairman of the AIEE Sections committee. Mr. Bower was born in Philadelphia, Pa., February 22, 1894, and was graduated from Drexel Institute in 1914. He commenced his career with the Public Service company in Camden, N. J., in 1914 as draftsman and in 1917 advanced to district chief clerk. After service with the United States Army he returned to the Public Service company in 1919 and became district foreman and assistant district line foreman. He was appointed local field engineer in 1924 and district superintendent in 1927. In 1943 he was made engineer in the general office of the company. Mr. Bower is a past chairman (1942–43) of the AIEE Philadelphia Section and has served as chairman of several committees of the Philadelphia Section. He has served on the national membership committee for the past year and is currently serving on the committee on planning and co-ordination of Institute activities.

R. H. Hughes (A '20, F '41) vice-president and general manager of the Manhattan, Bronx, and Westchester area of the American Telephone and Telegraph Company has been appointed staff vice-president of the company. Mr. Hughes entered the employ of the New York Telephone Com-

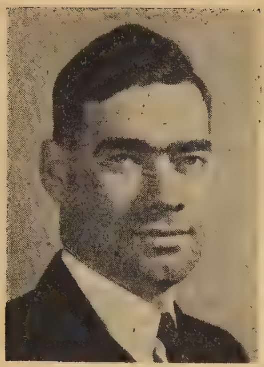
H. E. Wulfing

John Grotzinger



G. W. Bower

W. N. Zippler



S. B. Ingram

F. A. Cowan

G. A. Waters

pany, New York, in 1914. He became local trunk engineer in 1925 and plant extension engineer in 1927. Later that year he was made assistant vice-president of the company. He was appointed vice-president and general manager of the Bronx and Westchester area in 1939 and in 1941 added management of the Manhattan area to his duties. **W. A. Kietzman** (M '23) vice-president and general manager, New York Telephone Company, Albany, succeeds Mr. Hughes. Mr. Kietzman first worked for the American Telephone company from 1912 to 1921, as student engineer, assistant engineer, exchange rate practice engineer, and cost engineer. He joined the Bell Telephone Company of Pennsylvania, Philadelphia, as general commercial engineer in 1921. Returning to the American Telephone company in 1927 he became sales and directory engineer. From 1929 to 1938 he was general commercial engineer for the New York Telephone Company, New York, and in 1939 he was transferred to Albany as vice-president and general manager. **R. F. Davis** (A '25) formerly head of the exchange and special services group, American Telephone company, has been made station engineer in the plant engineering division. He has been with the Telephone company since 1921. **J. A. Parrott** (M '37) engineer for the Telephone company will succeed Mr. Davis as head of the exchange and special services group in the operation and engineering department of the American Telephone company. He has been employed by the telephone company since 1920.

F. A. Cowan (M '29) transmission engineer, American Telephone and Telegraph Company, New York, N. Y., has been appointed chairman of the AIEE technical program committee and the committee on award of Institute prizes for 1943–44. Mr. Cowan has been a member of the technical program committee since 1941. Born in Escatawpa, Ala., August 30, 1898, he received the degree of bachelor of science in electrical engineering from the Georgia School of Technology in 1919. In 1920 he entered the employ of the American Telephone and Telegraph Company, Atlanta, Ga., and was transferred in 1922 to the company's long lines engineering department in New York where he engaged in engineering work on special services. He became a division transmission engineer in the long lines plant department in 1926 and in 1928 was made engineer of transmission of the long lines department. Since 1940 he has been transmission engineer. Mr. Cowan has been a member of the AIEE committee on communications since 1941 and has served in several positions in the New York Section. The holder of patents on a number of inventions, he is also the author of various technical papers and articles. Mr. Cowan is a member of the Institute of Radio Engineers and holds the commission of lieutenant commander in the United States Naval Reserve.

S. B. Ingram (M '38) electronics research engineer, Bell Telephone Laboratories, Inc., has been appointed 1943–44 chairman of the AIEE committee on electronics of which he has been a member since 1942. Born October 8, 1903, in Bottineau, County, N. D., Mr. Ingram received the bachelor of arts degree from the University of British Columbia in 1925 and the degree of doctor of philosophy from the California Institute of Technology in 1928. From 1928 to 1930 he engaged in experimental and theoretical research in the atomic spectra of the light elements as a fellow of the National Research Council at the University of Michigan. In 1930 he joined the technical staff of Bell Telephone Laboratories to take charge of work on gas-filled vacuum tubes and in 1936 was named vacuum-tube development engineer. In 1939 he become electronics research engineer. During the past year, Mr. Ingram has served on the AIEE committee on communication. He is a fellow of the American Physical Society and an associate of the Institute of Radio Engineers.

G. A. Waters (A '09, F '21) chief engineer, electrical division, engineering department, Wagner Electric Corporation, St. Louis, Mo., has been appointed chairman of the AIEE committee on code of principles of professional conduct for 1942–43. Mr. Waters was born December 1, 1883, in Cleveland, N. Y., and was graduated from Syracuse University with the degree of bachelor of science in electrical engineering in 1907. From 1907 to 1909 he was instructor in mathematics and drawing at Washington University, St. Louis. He joined the Wagner Electric company as transformer designer in 1909 and in 1916 became plant engineer. In 1918 he was made assistant chief engineer and in 1926 was appointed chief engineer. Mr. Waters has been a member of the AIEE committee on electrical machinery since 1936.

M. L. Manning (A '36, M '42) formerly associate professor of electrical engineering, Illinois Institute of Technology, Chicago, has been appointed associate professor of electrical engineering and supervisor of the new high-voltage research laboratory at Cornell University, Ithaca, N. Y. Professor Manning holds the degrees of bachelor of science from South Dakota State College (1927) and master of science from the University of Pittsburgh (1932). From 1932 to 1936 he was instructor in the mathematics department of the University of Pittsburgh (Pa.) He was supervisor of the high-voltage laboratories of the Westinghouse Electric and Manufacturing Company, Sharon, Pa., as well as Westinghouse lecturer in electrical engineering on the staff of the University of Pittsburgh, from 1937 to 1942. In 1942 he was appointed to the staff of the Illinois Institute of Technology. **M. M. Peterson** (A '29, M '42) formerly laboratory engineer, Westinghouse Electric and Manufacturing Company, Sharon, Pa., has been appointed assistant professor of high-voltage practice in the new high-voltage laboratory at Cornell University. A 1927 graduate of Ohio Northern University, Professor Peterson was first employed by the Westinghouse company in 1928. Since 1931 he has been engaged in high-voltage research work.

D. S. Jacobus (A '03) retired consulting engineer of the Babcock and Wilcox Company, New York, N. Y., has been awarded the Miller Medal of the American Welding Society for the most conspicuous contribution to research, standardization, and advancement of welded construction. Born in Ridgefield, N. J., January 20, 1862, he was graduated from Stevens Institute of Technology in 1884 and received the degree of doctor of engineering in 1906. As a member of the faculty of the department of experimental mechanics of Stevens Institute, Hoboken, N. J., he served as instructor and assistant professor from 1884 to 1894. In the latter year he was made professor. In 1906 he joined the Babcock and Wilcox Company as advisory engineer and head of the engineering department. He is a past president of the American Welding Society, the Society of Refrigerating Engineers, and the American Society of Mechanical Engineers, as well as a member of the Society of Naval Architects and Marine Engineers, the American Institute of Mining and Metallurgical Engineers, the American Mathematical Society, the Society for the Promotion of Engineering Education, the American Association for

the Advancement of Science, and the Holland Society of New York.

P. M. Downing (A '98, F '42) vice-president and general manager, Pacific Gas and Electric Company, San Francisco, Calif., has been appointed executive vice-president. Mr. Downing has been associated with the Pacific Gas company since 1901 when he became manager in charge of engineering, construction, and business development of its predecessor, the Colusa Gas and Electric Company. In turn he worked as division superintendent for the Bay Counties Power Company, San Francisco, and superintendent of operation for the California Gas and Electric Company, San Francisco, until all three companies merged to form the Pacific Gas and Electric Company in 1905. In 1908 he was given general supervision of the operation and maintenance of hydroelectric and steam generating stations, transmission-lines substations, and distribution systems for the new company. With supervision of engineering design added to his duties in 1917, he became chief engineer in the electric department. He was made vice-president in charge of electric construction and operation in 1929, and in 1941 was named vice-president and general manager. Mr. Downing was a vice-president of the Institute from 1925 to 1927.

R. L. Frisby (A '17, M '27) electrical engineer, power plants, Kansas City (Mo.) Light and Power Company, has retired. Mr. Frisby's first engineering work was substation operation and maintenance for the Commonwealth Edison Company, Chicago, Ill., from 1903 to 1905. In the latter year he became central-station testing engineer. Leaving the Commonwealth Edison Company in 1919, he entered the employ of the Kansas City Light and Power Company to take charge of the operation, maintenance construction, and engineering of all generating stations. Mr. Frisby is a past chairman of the AIEE Kansas City Section.

F. A. Decker (M '39) formerly assistant professor of engineering, Texas College of Mines and Metallurgy, El Paso, has been appointed associate professor of engineering at the University of New Mexico, Albuquerque. Professor Decker received the degrees of bachelor of science in 1927 and electrical engineer in 1932 from Kansas State College. He was instructor in electrical engineering at the University of Arizona from 1928 to 1933, before joining the faculty of the College of Mines and Metallurgy in 1935.

A. B. Campbell (A '20, F '38) formerly engineer on the staff of the Edison Electric Institute, New York, N. Y., has become representative for the Eastern States for Hughes Brothers, Seward, Neb. Mr. Campbell joined the engineering staff of the EEI in 1933 after the dissolution of the National Electric Light Association with which he had been connected since 1923. His work with both organizations was in the fields of codes and standards, transmission and distribution, and accident prevention.

A. D. Pettee (A' 20, M '37) formerly district sales engineer, General Cable Corporation, Chicago, Ill., has been made technical superintendent of the corporation's Bayonne, N. J., plant. Before joining the General Cable Corporation in 1929, he was associated with the firm of D. C. and W. B. Jackson (now Jackson and Moreland), Boston, Mass.; the International Harvester Company, Chicago; and the New York (N. Y.) Edison Company.

Alexander Kennedy, Jr. (A '10, M '43) application engineer, federal and marine department, General Electric Company, Schenectady, N. Y., has been made assistant to the manager of the department. For the past ten years Mr. Kennedy has been application engineer on main propulsion turbines and gears designed and manufactured for Navy combat vessels, as well as for the merchant marine. He is a member of the Society of Naval Architects and Marine Engineers.

E. H. Howell (A '42) formerly manager of the Toledo, Ohio, office of the General Electric Company has been appointed manager of the company's meter and instrument division. Mr. Howell entered the employ of the General Electric Company, Schenectady, N. Y., in 1922 as a student engineer. He has since held the positions of transformer tester, transformer specialist, and manager of the Memphis, Tenn., office.

J. A. Davis (A '30, M '40) formerly general superintendent, transportation department, El Paso (Tex.) Electric Company, has been appointed manager of the transportation department of the Virginia Electric and Power Company, Norfolk. A 1927 graduate of Virginia Polytechnic Institute, Mr. Davis previously was associated with the Virginia Electric and Power Company from 1927 to 1939.

C. E. Nichols (A '39) formerly engineer, Tennessee Valley Authority, Washington, D. C., is now in charge of the Washington office of the American Warehousemen's Association, merchandise division. Associated with TVA since 1937, Mr. Nichols was head civil engineer and steam-plant project engineer at Knoxville, Tenn., before his transfer to Washington in 1942.

H. P. Richmond (A '36) formerly district manager, Jersey Central Power and Light Company, Dover, has been appointed general superintendent of operations for the company. Mr. Richmond entered the employ of the company in 1929 as a cadet engineer. He has been district manager since 1936.

H. H. Weber (A '27, F '40) formerly electrical engineer, wire division, United States Rubber Company, New York, N. Y., has been appointed sales manager of the wire and cable department. A 1917 graduate of Lehigh University, Mr. Weber joined the sales department of the United States Rubber Company in 1934.

H. J. MacLeod (A '23, M '39) head of the mechanical- and electrical-engineering departments, University of British Columbia, Vancouver, was made an officer of the Order of the British Empire in the King's Birthday Honors List for "valuable public service in connection with scientific research."

C. O. Bickelhaupt (M '22, F '28) vice-president-on-leave, American Telephone and Telegraph Company, New York, N. Y., and a colonel in the United States Army has been appointed commanding officer of the eastern Signal Corps replacement training center, Fort Monmouth, N. J.

E. F. Peterson (A '33) formerly engineer in the vacuum-tube engineering department, General Electric Company, Schenectady, N. Y., has been placed in charge of design engineering of receiving tubes. He has been employed by the General Electric Company since 1934.

W. G. Knickerbocker (A '20, M '30) formerly assistant superintendent of meters, Detroit (Mich.) Edison Company, has been appointed superintendent of meters. An employee of the Edison company since 1919, he had been assistant superintendent since 1929.

J. H. Yarnall (M '19) formerly assistant superintendent of power, Boston (Mass.) Elevated Railway, has been appointed superintendent of power for the railway. He has been employed by the Boston railway since 1906 and was named assistant superintendent of power in March 1943.

G. H. Teommey, Jr. (A '27, M '33) formerly assistant engineer, Consolidated Edison Company of New York, Inc., has secured a wartime leave of absence to join the Sperry Gyroscope Company, Garden City, N. Y.

F. A. Wahlers (A '35) formerly division, engineer, Consolidated Edison Company of New York (N. Y.), Inc., has been given a wartime leave of absence to join the Tennessee Eastman Corporation, Kingsport.

D. S. Wegg (A '08, M '20) formerly of the engineering department, American Writing Paper Corporation, Holyoke, Mass., is now an engineer with the firm of Jackson and Moreland, Boston, Mass.

OBITUARY • • • •

William Marcus Potts (A '36) chief electrician, Pacific Coast Borax Company, Boron, Calif., died June 16, 1943. He was born September 16, 1894, at Wynnewood, Okla., and was employed first as an electrician on mill and substation construc-

tion for the Bluestone Mining and Smelting Company, Mason, Nev., during 1919 and 1920. From 1920 to 1924 he worked as electrician on mine, mill, substation, and industrial-plant construction for the Pacific Gas and Electric Company, San Francisco, Calif.; the Standards Metals Company, Reno, Nev., the Moore Drydock Company, Oakland, Calif., and the Pan American Petroleum Company, Los Angeles, Calif. From 1924 to 1926 he held the position of chief electrician for the Pacific Coast Borax Company, Ryan, Calif. He did construction and maintenance work for the Bethlehem Shipbuilding Company, San Francisco, from 1926 to 1929. In 1929 he joined the May Automatic Oil Burner Company, Oakland, as electrician and salesman and in 1930 became a member of the firm, Frazier and Potts, Yerington, Nev. He returned to the Pacific Borax company in 1932 at Death Valley, Calif., becoming chief electrician at Hinkley, Calif., in 1933, and at Boron in 1938. He was a member of the American Institute of Mining and Metallurgical Engineers.

John E. Brobst (A '19) general consultant, industrial control engineering department, General Electric Company, Schenectady, N. Y., died September 30, 1943. He was born in Gilmanton, Wis., November 14, 1880, and was graduated from the University of Wisconsin with the degree of bachelor of science in electrical engineering in 1903. That year he was employed in the General Electric company's motor design department to work on design of d-c motors. After several years of special engineering assignments he was transferred, in 1916, to the industrial control department as assistant engineer. In 1920 he became designing engineer in that department. He was made works manager of the company's Bloomfield, N. J., plant in 1929 and in 1930 returned to Schenectady as managing engineer of the industrial control department. In 1943 he was appointed general consultant to the department. Mr. Brobst served on the AIEE committee on safety codes from 1927 to 1929 and is credited with several inventions related to motors and motor control.

Frederick Slocumb Freeman (A '16, M '28) superintendent of power, Boston (Mass.) Elevated Railway, died recently. He was born December 3, 1880, at Brookfield, Nova Scotia. After holding various positions connected with steam engineering, Mr. Freeman joined the Boston Railway in 1907 as mechanic and assistant chief engineer. In 1908 he was made chief engineer of the company's Dorchester power station and in 1911 of the South Boston power station. In 1913 he was appointed superintendent of power for the whole system which entailed responsibility for the operation and maintenance of all steam and power stations as well as supervision of construction of new projects.

James Percy Robinson (A '26) Pacific Coast manager, the Kerite Insulated Wire and Cable Company, Inc., San Francisco, Calif., died September 20, 1943. He was born August 14, 1887, in Washington, D. C. From 1906 to 1923 he worked as signal construction foreman, assistant supervisor of signal construction, and signal inspector for the Southern Pacific Railroad. In 1923 he joined the National Safety Appliance Company as signal engineer and in 1926 entered the employ of the Kerite Insulated Wire and Cable company as Pacific district representative. He was appointed manager of the district in 1940.

Theodore R. Cortright (A '43) engineer, C-O-Two Fire Equipment Company, Newark, N. J., died June 22, 1943. He was born August 19, 1919, at Berwick, Pa., and was graduated from Lehigh University with the degree of bachelor of science in electrical engineering in 1942. For six months following his graduation he was employed as junior engineer in the power drive department of the York (Pa.) Safe and Lock Company. In November 1942 he joined the C-O-Two Fire Equipment Company.

Otis C. Kirkman, Jr. (A '39) draftsman, Chattanooga (Tenn.) Electric Power Board, died May 21, 1943. Born in Cookerville, Tenn., December 7, 1916, he was graduated from the University of Tennessee with the degree of bachelor of science in electrical engineering in 1938. He had worked for the Electric Power Board since 1938 and was a member of Tau Beta Pi.

William John Wooldridge (A '06, F '38) retired manager of electrical sheet sales, Allegheny Ludlum Steel Corporation, Brackenridge, Pa., died April 6, 1943. He was a member of the AIEE committee on applications to iron and steel production for 1937–38. For an outline of Mr. Wooldridge's career see *Electrical Engineering*, August 1943, page 377.

MEMBERSHIP

Recommended for Transfer

The board of examiners, at its meetings on September 30 and October 21, 1943, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the national secretary.

To Grade of Fellow (September 30)

Miller, W. J., prof. and head, Dept. of Elec. Engg., University of Alabama, University, Ala.
Small, Alvah, president, Underwriters' Labs., Inc., Chicago, Ill.

2 to grade of Fellow

To Grade of Member (September 30)

Adams, C. C., chief engr., Quality Electric Co., Los Angeles, Calif.
Alliason, A. R., prof. and head of Dept. of Elec. Engg., Wayne University, Detroit, Mich.
Appleby, C. D., supt. of Municipal Utilities, Town of Middletown, Del.
Bell, J. S., development engr., Western Electric Co., Kearny, N. J.
Bliss, W. H., research engr., RCA Laboratories, Riverhead, N. Y.
Boyajian, J. A., chief engr., Metal Specialties Mfg. Co., Chicago, Ill.
Brown, E. C., acting mgr., Connecticut Valley Power Exchange, Hartford, Conn.
Brown, N. F., engr., accountant, Southern California Edison Co. Ltd., Los Angeles, Calif.
Cordray, R. E., charge of relay engg., General Electric Co., Philadelphia, Pa.
Daus, G. A., relay engr., Public Service Co. of Northern Illinois, Maywood, Ill.
Davis, E. W., group head, electrical, Standard Oil Development Co., Elizabeth, N. J.
Dynes, W. A., project engr., AAF Matériel Command, Wright Field, Dayton, Ohio.
Edgar, R. F., section head, General Engg. Lab., General Electric Co., Schenectady, N. Y.
Graves, H. C., elec. engr., ITE Circuit Breaker Co., Philadelphia, Pa.
Harries, W. H., associate elec. engr., Bonneville Power Administration, Portland, Oreg.
Hertzler, E. A., associate prof., Pratt Institute, Brooklyn, N. Y.
Hornfeck, A. J., elec. research engr., Bailey Meter Co., Cleveland, Ohio.
Hutchings, J. H., chief engr., Continental Electric Co., Geneva, Ill.
Jayne, G. E., Dover, N. J.
Keck, J. N., elec. designer, James Stewart Co., Chicago, Ill.
Kirkland, J. F., asst. supt., Diesel Div., Baldwin Locomotive Works, Philadelphia, Pa.
Kirkwood, R. H., Major, A.U.S., New York.
Kopper, J. M., instructor in elec. engg., Johns Hopkins University, Baltimore, Md.
Lang, G. F., street lighting engr., Public Service Co. of Colorado, Denver, Colo.
Lewis, M. T., Port Signal Officer, U. S. Army, Fort Mason, Calif.
Limpus, L. M., supt. of Reclamation Dept., Oklahoma Gas & Electric Co., Oklahoma City, Okla.
Linke, H. M., chief operator, Spruce Falls Power & Paper Co. Ltd., Kapuskasing, Ont., Can.
Long, H. H., general engr., Knoxville Electric Power & Water Board, Knoxville, Tenn.
Long, R. P., General Plant Mgr., Bell Telephone Co. of Pa., Philadelphia, Pa.
Martin, L. D., senior electrical engr., U. S. Engineers, Atlanta, Ga.
Mayott, C. W., mgr., Connecticut Valley Power Exchange, Hartford, Conn.
Meyer, C. A., elec. design engr., Public Utility Engg. & Service Corp., Chicago, Ill.
Montgomery, W. E., chief load dispatcher, Basic Magnesium, Inc., Las Vegas, Nev.
Morton, P. L., asst. prof. of elec. engg., Univ. of California, Berkeley, Calif.
Oliver, T. S., underground engr., Public Service Co. of Colorado, Denver, Colo.
Pack, H. T., elec. supt., West Coast Shipbuilders, Ltd., Vancouver, B. C., Can.
Rader, L. T., elec. engr., General Electric Co., Schenectady, N. Y.
Reed, M. B., prof. of elec. engg., Illinois Institute of Technology, Chicago, Ill.
Rue, E. C., asst. supt., Trans. & Dist., Boston Edison Co., Boston, Mass.
Schmitt, G. E., chief engr., Lower Colorado River Authority, Austin, Tex.
Schulz, E. H., instructor in elec. engg., Illinois Institute of Technology, Chicago, Ill.
Shutt, C. C., mgr., Small Motor Div., Westinghouse Elec. & Mfg. Co., Lima, Ohio.
Stauder, L. F., associate prof. of elec. engg., Univ. of Notre Dame, Notre Dame, Ind.
Steede, J. H., asst. to chief engr., British Columbia Elec. Railway Co. Ltd., Vancouver, B. C., Can.
Thielman, J. A., senior engr., Philadelphia Electric Co., Philadelphia, Pa.
Umphrey, D. M., central station elec. engr., Westinghouse Electric & Mfg. Co., Wilkinsburg, Pa.
Vernam, G. S., senior engr., Postal Telegraph-Cable Co., New York.
Ward, R. T., In charge of Expediting of electrical Equipment, Aluminum Co. of Canada, Montreal, Can.
Watkins, D. L., product engr., American Steel & Wire Co., Worcester, Mass.

49 to grade of Member

To Grade of Fellow (October 21)

Buehner, R. O., elec. engr., American Steel & Wire Co., Cleveland, Ohio.
Hoeppner, H. L., elec. engr., Public Utility Engg. & Service Corp., Chicago, Ill.

2 to grade of Fellow

To Grade of Member (October 21)

Connery, A. F., chief engr., Postal Telegraph Cable Co., New York.
Day, J. H., engr., I.T.E. Circuit Breaker Co., Philadelphia, Pa.
Dempsey, W. A., Lieut., U. S. Naval Reserve, Washington, D. C.
Dryar, H. A., chief load dispatcher, Philadelphia Elec. Co., Philadelphia, Pa.

Emrick, A. N., mgr., Wagner Electric Corp., Dallas, Texas.
Figentzer, Theodore, elec. engr., J. Gordon Turnbull & Sverdrup & Parcel, St. Louis, Mo.
Fuge, H. B., elec. engr., Diehl Mfg. Co., Finderne Plant, Somerville, N. J.
Garman, G. W., sales and application engr., General Electric Co., Schenectady, N. Y.
Hilbert, E. H., methods engr., Ward Leonard Elec. Co., Mount Vernon, N. Y.
Jolliff, E. N., field service engineer, Crouse-Hinds Co., Houston, Texas.
Kofoid, M. J., research engr., Westinghouse Research Labs., East Pittsburgh, Pa.
McCall, C. C., system operator, Cleveland Electric Illuminating Co., Cleveland, Ohio.
Nason, H. E., district engr., Westinghouse Elec. & Mfg. Co., Chicago, Ill.
Rutter, A. R., mgr. of engg., Westinghouse Elec. & Mfg. Co., Newark, N. J.
Stumpf, M. W., asst. elec. engr., New Orleans Public Service, Inc., New Orleans, La.
Warrington, A. R., In charge of application, relay section, General Elec. Co., Philadelphia, Pa.
Wollaston, F. O., supt., B. C. Electric Railway Co., Vancouver, B. C., Canada.

17 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. Any member objecting to the election of any of these candidates should so inform the national secretary before November 31, 1943, or January 31, 1944, if the applicant resides outside of the United States or Canada.

To Grade of Member

Allen, R. C. (Re-election), Gibbs & Cox, Inc., New York, N. Y.
Andrews, R. A., Ward Leonard Elec. Co., Mount Vernon, N. Y.
Bascum, O. A. (Re-election), West. E. & M. Co., Lima, Ohio.
Beaver, G. L. (Re-election), Gen. Elec. Co., San Francisco, Calif.
Bowers, R. H., Mutual Boiler Ins. Co., New Orleans, La.
Braswell, R. W., Louisiana Pr. & Lt. Co., New Orleans, La.
Bratiotis, C. D., U. S. Navy Yard, Portsmouth, N. H.
Cam, W. G. H., Canada Cement Co., Ltd., Montreal, Que., Can.
Choyce, N. B., Loft Candy Corp., Long Island City, N. Y.
Coyne, R. D., Jackson & Moreland, Boston, Mass.
Croft, P. J., Power Corp. of Canada, Montreal, Que., Can.
Daughtrey, L., Jr., Rowan Controller Co., New York, N. Y.
Davison, W. E., Shawinigan Water & Power Co., Montreal, Que., Can.
Emley, P. W., Cutler-Hammer, Inc., Milwaukee, Wis.
Fulton, R. B., Allis-Chalmers Co., Pittsburgh, Pa.
Gregory, P. S. (Re-election), Shawinigan Water & Pr. Co., Montreal, Que., Can.
Haskens, A. J. (Re-election), U. S. Navy, San Pedro, Calif.
Herrington, G. T., Arizona Elec. Power Corp., Flagstaff, Ariz.
Holt, W. A., Baker & Co., Inc., Newark, N. J.
Howard, A. W., Montreal Engg. Co., Montreal, Que., Can.
Johns, W. T., Jr., Rumsey Elec. Co., Richmond, Va.
Jones, R. E., Bail-Horton Co., Jacksonville, Fla.
Littell, C. C., Jr., Lear Avia., Inc., Piqua, Ohio.
Moale, E. S. (Re-election), Lieut. Comdr., U. S. Navy Houston, Texas.
Mortara, M., Cons. Gas & El. L. & P. Co., Baltimore, Md.
Ram Prasad, B. K., Jog Hydro Electric Power Scheme, Bangalore, India.
Reid, R. F., Penn. Shipyards, Inc., Beaumont, Tex.
Shelhorse, A. W. (Re-election), Georgia Power Co., Atlanta, Ga.
Shipley, F. F., Bell. Tel. Labs., Inc., New York, N. Y.
Simmons, W. R., Montreal Tramway Co., Montreal, Que., Can.
Tewes, K. H., Sorel Industries, Ltd., Sorel, Que., Can.
Thurling, M. C., Canadian Gen. Elec. Co., Ltd., Montreal, Que., Can.
Weaver, A. B., Rural Electrification Adm., St. Louis, Mo.
Williams, J. A., Pacific Bridge Co., Alameda, Calif.
Zawacki, E. F., Lewis Engg. Co., Naugatuck, Conn.

35 to grade of Member

To Grade of Associate

United States and Canada

1. North Eastern

Bos, J., Eastman Kodak Co., Rochester, N. Y.
Bronaugh, A. T., Jr., U. S. Army, Cambridge, Mass.
Doersam, P. D., Harvard University, Cambridge, Mass.
Dunn, C. H., Univ. of New Hampshire, Durham, N. H.
Hazelwood, C. F., Jr., Gen. Elec. Co., Schenectady, N. Y.
Miller, J. J., General Motors Corp., Rochester, N. Y.
Reid, W., Landers, Frary & Clark, Newington, Conn.
Schwarting, W. H., Western Union Tel. Co., Buffalo, N. Y.
Ware, P. H., Simplex Wire & Cable Co., Cambridge, Mass.
Wilson, W. R., Gen. Elec. Co., Pittsfield, Mass.

2. Middle Eastern

Abbott, H. L., Lieut., U. S. Army, Philadelphia, Pa.
Biedenbender, R., Crosley Radio Corp., Cincinnati, Ohio.
Bond, C. R., Ohio Edison Co., Akron, Ohio.
Bukstein, M., Sig. Corps Insp. Agency, Dayton, Ohio.
Burgin, E. R., I-T-E Circuit Breaker Co., Philadelphia, Pa.
Cummins, H. R., Westinghouse E. & M. Co., Mansfield, Ohio.
Fletcher, K. V., Gen. Elec. Co., Philadelphia, Pa.
Getz, J. F., Roller Smith Co., Bethlehem, Pa.
Hoffecker, J. I., Westinghouse E. & M. Co., Akron, Ohio.
Lomis, I., United Engr. & Constr., Inc., Philadelphia, Pa.
Mason, H. M., U. S. Maritime Comm., Washington, D. C.
Moore, F. B., Cons. Molded Prod. Corp., Scranton, Pa.
Morgan, R. H., West. E. & M. Co., Sharon, Pa.
Parker, L. L., Glenn L. Martin Co., Baltimore, Md.
Randolph, H. T., Washington Sub. San. Comm., Hyattsville, Md.
Rix, R. W., Cleveland Elec. Ill. Co., Cleveland, Ohio.
Stewart, E. W., Phila. Elec. Co., Philadelphia, Pa.
Sutton, D. E., I-T-E Circuit Breaker Co., Philadelphia, Pa.
Watkins, J. E., Phila. Sig. Corps Proc. Dist., Philadelphia, Pa.

3. New York City

Barlow, W. A., General Winding Co., New York, N. Y.
Christiansen, E. G., Ward Leonard Elec. Co., Mount Vernon, N. Y.
Hovemeyer, W. E., Newark Sig. Corps Insp. Zone, Newark, N. J.
Kahn, E. L., S. W. Farber, Inc., Brooklyn, N. Y.
Kettell, J. E., H. A. Fraser, Inc., New York, N. Y.
Kourides, G. T., Newark Sig. Corps Insp. Zone, Newark, N. J.
Kunis, W., Ward Leonard Elec. Co., New York, N. Y.
Lathrop, C. M., Standard Oil Dev. Co., Elizabeth, N. J.
Lensner, H. W. (Re-election), Westinghouse E. & M. Co., Newark, N. J.
Littlejohn, H. F., Jr., Ward Leonard Elec. Co., New York, N. Y.
Mainberger, W. A., College of City of N. Y., New York, N. Y.
McGowan, F. J., Anaconda Wire & Cable Co., Hastings-on-Hudson, N. Y.
McHale, F. J., M. W. Kellogg Co., New York, N. Y.
Michaels, S. J., Anaconda Copper Mining Co., New York, N. Y.
Mozzi, F. J., Newark Sig. Corps Insp. Zone, Newark, N. J.
Nidzyn, J. J., Fairchild Aviation Corp., New York, N. Y.
Peterson, O. G., Sperry Gyroscope Co., Brooklyn, N. Y.
Pynn, T. E., Capt., U. S. Army, Red Bank, N. J.
Ryan, T. R. (Re-election), Amer. Steel & Wire Co. of N. J., New York, N. Y.
Sundell, C. W., E. B. Badger & Sons Co., New York, N. Y.
Torch, H. T., Lieut., U.S.N.R., Tompkinsville, N. Y.
Townend, W. H. S., Newark Sig. Corps Insp. Zone, Newark, N. J.
Zahardis, N. G., Lieut., U.S.M.S., Brooklyn, N. Y.

4. Southern

Hemker, H. F., Gen. Elec. Co., Memphis, Tenn.
Kastner, R. M., Ensign, U. S. Navy, Portsmouth, Va.
Segall, B. (Re-election), New Orleans Pub. Serv., Inc., New Orleans, La.
York, M. M., Allis-Chalmers Mfg. Co., Charlotte, N. C.

5. Great Lakes

Casteel, D. O., Bendix Prod. Div., South Bend, Ind.
Cohn, G. I., Lieut., U. S. Army, Lake Forest, Ill.
Donnelly, A. V., Iowa State Univ., Iowa City, Iowa.
Hill, W. D., Commonwealth Edison Co., Pekin, Ill.
Kramer, F. C., Naval Training School, Ames, Iowa.
Kuhn, H., Kurz & Root Co., Appleton, Wis.
McKnight, B. E., Gen. Elec. Co., Fort Wayne, Ind.
Oden, C. M., Commonwealth Edison Co., Chicago, Ill.
Pharmer, W. L., Gen. Electric Co., Fort Wayne, Ind.
Poer, N. V., Gen. Motors Corp., Anderson, Ind.
Rouse, W. H., Cutler Hammer, Inc., Milwaukee, Wis.
Sawyer, R. A., Gen. Elec. Co., Fort Wayne, Ind.
Schlicher, D. W., Iowa State College, Ames, Iowa.
Schulte, R. F., Gen. Elec. Co., Fort Wayne, Ind.
Stephens, T. C., Iowa State Univ., Iowa City, Iowa.
Taskin, H. A. K., Marquette Univ., Milwaukee, Wis.
Thibodeau, A. J., Ford Motor Co., Dearborn, Mich.

6. North Central

Bitney, W. L., City of Lincoln Water & Lt. Dept., Lincoln, Nebr.
Hampton, P. E., Loup River Pub. Pr. Dist., Columbus, Nebr.
Kester, S. J., Gen. Elec. Co., Denver, Colo.
Porter, W. A. (Re-election), Pub. Serv. Co. of Colo., Denver, Colo.
Shute, C. D., Pub. Serv. Co. of Colo., Denver, Colo.

7. South West

Adams, S. L., Gulf States Utilities Co., Beaumont, Tex.
Boyd, R. L., Westinghouse E. & M. Co., St. Louis, Mo.
Cady, W. M., Penn. Shipyards, Inc., Beaumont, Tex.
Cloninger, F. M., Pub. Serv. Co. of Okla., Tulsa, Okla.
Collins, D. O., Union Elec. Co. of Mo., Festus, Mo.
Dill, J., Jr., Kansas Gas & Elec. Co., Wichita, Kans.
Dry, J. E., Superior Elec. Co., Dallas, Tex.
Gibson, J. V., U. S. Engineers, Denison, Tex.
Glidden, D. L., Graybar Elec. Co., Inc., Houston, Tex.
Gosnell, R. F., Southwestern Bell Tel. Co., St. Louis, Mo
Hopkins, R. O., Gulf States Utilities Co., Beaumont, Texas.
Jansen, C. H., Lummus Co., Houston, Tex.
Jenkins, J. H., Sandford Cons. Co., Oklahoma City, Okla.
Kinzer, E. F., Houston Ltg. & Pr. Co., Houston, Texas.
Kongabel, H. J., West. E. & M. Co., El Paso, Tex.
Lehmberg, M. M., Houston Ltg. & Pr. Co., Houston, Tex.
Parmelly, J. H., Humble Pipe Line Co., Odessa, Texas.
Plumer, W. H., Southwestern Bell Tel. Co., Tulsa, Okla.
Stuemky, E. R., Southwestern Bell Tel. Co., Tulsa, Okla.
Sutter, C. H., Kansas Gas & Elec. Co., Wichita, Kans.
Sutton, H. J., Gulf States Utilities Co., Beaumont, Tex.
Taulman, J. W., Jr., Lock Insulator Corp., Dallas, Tex.
Terhune, R. S., Nelson Mfg. Co., Tulsa, Okla.
White, J. H., Rural Electrification Adm., St. Louis, Mo.

8. Pacific

Bjerrum, L. N., Douglas Aircraft Corp., El Segundo, Calif.
Cokliss, O. E., Cons. Vultee Aircraft Corp., San Diego, Calif.
Daniell, H. E., Moore Dry Dock Co., Oakland, Calif.
Humphrey, E. L., Fischbach & Moore, Inc., Richmond, Calif.
Meisenheimer, L. F., Lieut. (j.g.), U. S. Navy, San Francisco, Calif.
Ossin, J. S., U. S. Navy, San Francisco, Calif.
Roosenberg, P., San Diego Gas & Elec. Co., San Diego, Calif.
Snyder, L. G., Lieut., U.S.N.R., Burbank, Calif.
Starr, A. B. (Re-election), U. S. Govt. Pub. Wks. Dept., San Diego, Calif.
VanWagenen, H. W., Parker Elec. Supply, Parker, Ariz.

9. North West

Crosby, R. E., Washington Water Pr. Co., Spokane, Wash.
DeCourcey, D. G., Boeing Aircraft Co., Seattle, Wash.
Levin, E., Boeing Aircraft Co., Seattle, Wash.
Sander, W. C., Wash. Water Power Co., Spokane, Wash.
Schleif, F. R., U. S. Bur. of Reclamation, Coulee Dam, Wash.
Seibel, R. C., Montana State College, Bozeman, Mont.
Westlake, P. R., 1st Lieut., U. S. Army, Seaside, Oreg.
Wollert, A., Capt., U. S. Army, Fort Lewis, Wash.

10. Canada

Cuff, J. V., Amalgamated Electric Corp., Ltd. Toronto, Ont., Can.
Phelan, A. J., Northern Elec. Co., Montreal, Que., Can.
Ross, V. B., Canadian Gen. Elec. Co., Toronto, Ont., Can.

Elsewhere

Bogen, S., Stowe Elec. Pty., Ltd., Sydney, Aus.

Total to grade of Associate
United States and Canada, 123
Elsewhere, 1

OF CURRENT INTEREST

New Frontiers in Rubber Revealed in Recent Address

One of the greatest problems facing the rubber industry today is that of improving the quality of synthetic rubber, Edwin J. Thomas, president of the Goodyear Tire and Rubber Company, Akron, Ohio, stated in a recent address before the Engineering Society of Detroit.

After months of confusion and countless experiments, he reported, a new material has been evolved which will be the basis of rubber manufacturing in the United States at least for the duration of the war. Although the postwar position of synthetic rubber is still a matter for much conjecture, various factors indicate that it will take its place beside crude rubber according to the future value of each.

In order to present the status, and the future direction of the rubber program now in operation, Mr. Thomas briefly reviewed the beginnings of the rubber crisis. The essential substance of his address, "New Frontiers in Rubber," follows.

The United States always has been the largest consumer of rubber among the nations of the world. In the years before Pearl Harbor, the average annual consumption of crude rubber was somewhat more than a half-million tons, most of which came from halfway around the world.

Because of the great distances involved, it had been necessary and customary to keep approximately six months' supply of crude rubber on hand in this country. But when the war broke out in Europe in 1939, the country's inventories were at an extremely low level—125,000 tons, or only two months supply. Our reserve was subnormal because the price of crude rubber, fixed through British–Dutch agreements, was too high to make normal forward buying advisable.

Bitter experience with rubber shortages in World War I led the rubber industry to begin urging the government to build up more substantial crude-rubber inventories against a possible emergency. For its part, the industry began to build up its own stocks insofar as it was financially able, but it lacked the funds for a heavy gamble in such a highly volatile market. Furthermore, to provide national insurance in time of war, huge rubber reserves were needed for which only the government could make the necessary arrangements. Accordingly they were made, and the government's reserve stock of rubber began to grow.

Besides advocating government-created stockpiles of crude rubber, private industry urged the government to establish a number of small synthetic plants—test cases which would lead to knowledge of and experience in the production and handling of synthetic rubber, and which would furnish the pattern for plant design and production formulas. Pending government action, some of the companies set up such small plants at their own expense.

When the Japanese attack was launched against us at Pearl Harbor, our crude-rubber stockpile had been increased from 125,000 to 533,000 tons, and four months later it had been built up to 634,000 tons. This was more than a normal year's supply but less than was consumed during the peak year 1941, when 775,000 tons of rubber were processed to meet the high production of the automotive industry, the forward buying of the public, and the developing military needs.

Concurrent with this reserve came strenuous conservation in the use of existing rubber products in the form of low speed limits, mileage and tire rationing, and similar precautions. Efforts were made to accumulate large supplies of scrap rubber, and to develop the sources of jungle rubber—guayule, cryptostegia, and others. Every ounce of rubber of any description assumed the stature of a national asset.

At this time, in broad outline, the rubber problem could be analyzed in terms of simple arithmetic:

1. There was so much crude rubber on hand, plus unused mileage in the tires on the wheels.

2. A minimum of so much rubber would be required for the prosecution of the war and the maintenance of the home front.

3. There remained only so much time in which to provide a substitute supply before existing stocks were exhausted.

Those were its basic elements. They were not exact to the last pound or the last day, but their approximations afforded an ample base for emergency planning. In the face of these fixed facts, however, there ensued a period of utmost uncertainty and confusion. All manner of unsound proposals were brought forward, and to the bewilderment of public thinking, most of them made the front pages of the daily newspapers.

Fortunately for America, the scientific researchers of the rubber industry possessed a sound working knowledge of the synthetic field, both at home and abroad. It was known that the Germans had been working along this line since shortly after the first World War. Representatives sent to discover their progress, although for the most part given a polite run-around, satisfied themselves that the United States had kept abreast of all developments over there. At home, several industries were working indefatigably on independent research and comparing notes. Even the universities began directing their graduate research toward this problem.

Then the Japs struck at Pearl Harbor. A few months later they had conquered Malaya and the East Indies—the source of 90 per cent of our crude-rubber supplies. It was then, of all times, that the era of confusion developed.

On the side of definite action, the Rubber Reserve Corporation had been created to handle the stockpiling and to initiate a synthetic-rubber plant-building program. But on the side of unfinished business there was a massing of detail. Designs for butadiene and styrene plants needed completion. The best standard process for manufacturing synthetic rubber had to be decided upon. The size of the program was still to be determined. Most of the processing and converting problems of the manufacturer remained to be perfected. Labor and materials became short, and military and civilian authorities squabbled over the right to obtain what critical materials were available.

It was not until September 1942—nine months after Pearl Harbor—that the Baruch report, made by the committee consisting of Bernard Baruch, chairman; Doctor Karl T. Compton, president of Massachusetts Institute of Technology; and Doctor James B. Conant, president of Harvard University, brought an end to this confusion and fixed our national course. As called for by the report, a rubber director, William M. Jeffers, was appointed. He accepted the objectives fixed by the report as a definitive course of procedure, and the program was undertaken at once.

In detail, the program called for establishing 14 polymerization plants for the manufacture of buna *S* rubber, with 23 plants for butadiene and seven plants for styrene. Three plants for butyl and one for neoprene were included. The total capacity was to be 850,000 long tons, which called for a government outlay of over half a billion dollars. The plants were to be owned by the government and operated by the various oil, chemical, and rubber companies, and the whole program had to be completed ahead of the time when our existing stocks of crude rubber would be depleted.

Under the spur of possible military defeat, technical problems of plant design and operations were worked out. Even while the technicians were agreeing upon such matters, contractors and producers of building materials and manufacturing machinery were straining every effort to beat a fateful deadline.

Today those great butadiene, styrene, and polymerization plants are fast coming into full production. Meanwhile, the rubber manufacturers had cut their usage of crude rubber from 775,000 tons in 1941 to 377,000 tons in 1942, and the 1943 con-

sumption has been reduced further to 300,000 tons. At the same time, 175,000 tons of synthetic production will be available this year.

At the beginning of 1944 at least 125,000 tons of crude rubber will still remain in our national stockpile, with synthetic plants producing at a rate of 800,000 tons per year. From 35,000 to 50,000 tons of crude rubber will be imported from Latin America, and an additional 100,000 tons will be added to the United Nations' pool from Ceylon and Africa.

These figures bring the rubber program up to date factually. But how to interpret them in regard to future developments?

As the situation stands now, for general purposes, synthetic rubber is not equal to crude rubber in performance or adaptability. The greatest drawbacks are its lower elasticity, and its lower elongation which tend to shorten progressively under the influence of heat and aging. One of its good points is its abrasion resistance.

Another important drawback is the effect on processing capacities when synthetic rubber is used. There is a 20 to 25 per cent reduction in processing capacity, particularly in connection with milling and mixing operations. It simply takes longer to get the rubber in shape to use for the processes that follow. More machinery with higher priority ratings is needed without delay to circumvent this loss.

Then, there is the quality of the product as compared with that made from crude rubber. At present, no tire made from synthetic rubber will equal the best crude-rubber tire in performance. In passenger-car tires made with 100 per cent synthetic rubber, the American motorist will find adequate satisfaction if he observes the present speed limits. There will be some problems with cutting and chipping of the treads, and more bruising and separation at higher speeds, but they will wear reasonably well.

However, truck tires made of 100 per cent, or a high percentage of synthetic rubber, present many more difficulties, especially in the larger sizes, where speed and load make the generation of heat a serious problem. This handicap, present in prewar tires made from crude rubber, is heightened by the use of synthetic rubber. A great deal of tread cracking, tread cutting, and separation is experienced, and many blowouts occur. Some new tread designs appear helpful. Truck tires built of rayon cording stand up much better than those from cotton cord, and treads built less thick wear best under the severe heat conditions. Technical men of the United States Army, the government, and the rubber industry are concentrating on this problem. However, truck tires will be made from one-half crude rubber and one-half synthetic rubber until these difficulties can be overcome.

At the present time, the rubber industry is running at peak capacity. In addition to a huge military load, an essential civilian load must be met now. For 1944, the military demand has increased over that in 1943, and much of this comes in large-size truck and airplane tires that require the greatest amount of labor, space, and milling capacity. Also, civilian truck needs will be the greatest in history, and tractor tires for food production will further tax production facilities.

Ordinarily, civilians need 30,000,000 to 35,000,000 new tires each year to keep their cars running. Since tire rationing, the public has been provided with only about 17,000,000 tires—5,000,000 synthetic passenger tires, 7,000,000 from pre-Pearl Harbor stocks, and 1,000,000 fully reclaimed tires—plus recaps. One of the greatest national assets was the quality and available mileage in the tires on the cars of Americans when the supply of crude rubber was cut off.

With synthetic rubber available, the industry is faced with supplying a minimum of 30,000,000 new tires to keep the essential cars operating in 1944. Whether it can do this as well as carry the military demands will depend upon getting more production from present machinery, quickly securing additional capacity, its ability to secure sufficient cord and rayon fabric, and upon relief from the man power shortage.

The best postwar future for the rubber industry will be in the products it furnished before the war. The demand for renewal tires will be enormous. Tires for original equipment will be needed in greater quantities than ever before. Huge vacuums, created by wartime shortages, must be filled in all rubber products.

In the postwar world there will be new and better machines in rubber processing. A huge field in insulation lies ahead. One product in this line now in operation seems to do an outstanding job in fulfilling military needs. The field of vibration damping is opening up. The use of Pliofilm, a rubber resin in sheet form, for wrapping packages, fruits, machinery, airplane engines, and so forth, is almost unlimited, as well as rubber- and resin-coated papers. The use of rubber for flooring and walls is almost untouched. New yarns and fibers now under development will make better products. Various plastics, with and without rubber, can be used with advantage to the rubber companies. Man-made rubber offers an opportunity of adapting this basic material to fit a variety of requirements never possible heretofore.

United States Replaces Germany in Developing Uruguayan Power

With United States engineering and financing replacing German on a Uruguayan dam project brought to a standstill by that country's severing relations with the Axis nations in 1942, the project is expected to begin delivering power in 1945.

Located on the Black River which crosses the entire country from northeast to southwest, the new dam will add 121,600 kw to Uruguay's present power capacity of 110,000 kw. The contract for the first of the four 30,400-kw waterwheel generators has been awarded to the International General Electric Company. The unit will stand 25 feet high with an over-all diameter of 39 feet. Funds for completing the project were obtained from a United States Export–Import Bank loan of $12,000,000 to the Uruguayan government. Prior to the Black River project the country's only large power stations were two steam plants in Montevideo. The rest of the country, which supports two thirds of the population of $2,500,000 persons, was supplied chiefly by isolated plants operated by imported oil. When the war cut off imports, Uruguay was confronted with power shortages which threatened to become as serious as those in Argentina, where, because of coal shortages, one ton of corn must be added to three of coal in steam-power stations.

The increased power supplied by the dam is expected to change present conditions, whereby the majority of manufacturing plants are concentrated at Montevideo, and cause industrial expansion in the hinterland. Rural electrification, flood control, irrigation, river transportation facilitating trade between the farms and the industrial markets, and increased mining activity are among the other benefits the dam will provide throughout the 26,000 square miles drained by the 530-mile Black River.

The dam itself, 130 feet high and 3,850 long, will create a normal storage of about 9,000,000 acre-feet, while additional flood storages of 3,000,000 acre-feet are contemplated. The lake built up by the dam will extend upstream for 87 miles with a maximum width of 18 miles.

WPB Studies War Uses for Stained Mica

Finding a war use for the surplus of lower-grade mica now accumulating in government stockpiles is occupying a research program instituted by the War Production Board. WPB's success in increasing the supply of the better-quality mica is responsible for building up stocks of mica rejected under present standards for uses other than electrical insulation, spark plugs, and some radio tubes. If the results of this new program are satisfactory there will be a supply of the stained qualities of mica sufficient to compensate for the shortage of the clearer qualities.

Since the manufacture of capacitors is the greatest single use for mica, the National Research Council has set up a research project at Bell Telephone Laboratories, Inc., to reconsider the types of mica that might be suitable for their manufacture.

In the course of its mica-testing program, instruments that will measure the electrical qualites of mica have been developed by the laboratories. By means of these instruments various inferior qualities of mica were found to be free from conducting veins and spots, and as low in power loss as mica free from stain. A limited number of capacitors made from the stained mica seemed to indicate that in most respects the capacitors are as satisfactory as those fabricated from the better-quality mica.

On the basis of this preliminary work, the WPB took a wider sampling of the mica heretofore termed inferior. Additional sets of testing instruments were built, and nine different types of mica not ordinarily used for capacitors, six of domestic and three of foreign origin, were tested. Tested at that time was $1^1/_2$ tons of mica which has now been distributed among various manufacturers for use in assembling specified capacitors. These capacitors must then measure up to the usual performance specifications of the armed forces.

Anticipating that the capacitors will pass military inspection and that the stained mica then will be admitted into general usage, the American Society for Testing Materials is preparing necessary specifications covering natural block mica for use in capacitors, and it is expected that tentative standards soon will be adopted. To meet the specifications under consideration, the mica must test satisfactorily on the Bell Laboratories' instruments for power loss and absence of conducting veins and spots and must meet such physical standards as flatness, ease of cleavage, hardness, and freedom from cracks and pinholes. Use of the instruments does not obviate the need for visual inspection which alone can discover such defects as excessive waviness, softness, and the presence of minute particles of rock.

Although all the mica tested to date is included in the present buying program of the Colonial Mica Corporation (the government agency), and no change in procurement policy will be made until the testing has been completed, preparations for a new buying program are being made. Samples of mica from all principal domestic mines including those now supplying the Colonial Corporation and those now considered to be nonstrategic are being tested. The facilities of the Corporation's offices at Asheville, N. C., Newport, N. H., and Custer, S. Dak., are available to neighboring mines. Operators of mines considered nonstrategic are urged to contact the nearest office to arrange for samples to be tested. A statement of the results then will be given the mine operator.

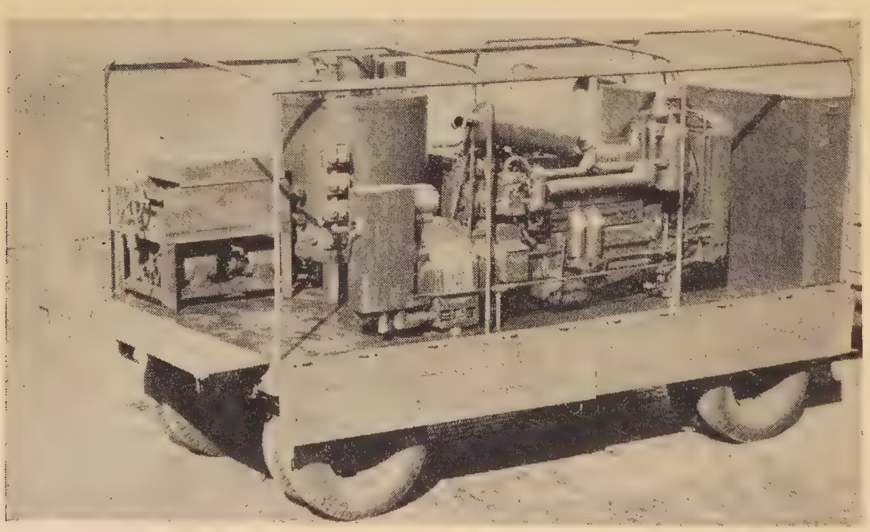
Technical Advisory Service Available to Small Plants

A technical advisory service, set up by regions throughout the United States to serve the interests of small plants, has been established recently by the Smaller War Plants Corporation, according to Brigadier General Robert W. Johnson, chairman. The service will put at the disposal of the small manufacturer who requires technical research in the solution of a production problem information drawn from government agencies, trade associations, technical and scientific organizations, technical-magazine editors, and the research laboratories of educational institutions and private industry.

The service derives from an idea that has been applied successfully in private business since 1937 by Bert. H. White, vice-president of the Liberty Bank of Buffalo, N. Y., who is now on leave as a major in the United States Army Air Forces in order to establish the technical advisory service. A six-week indoctrination course, given by Major White at the University of Buffalo, trained representatives from each of the 14 SWPC regional offices in the administration of the technical advisory service.

The service itself does not engage in industrial research or testing, and for the most part is available without charge to all small manufacturers. In a few cases, where the nature of the information sought is such that it can be obtained only from commercial testing laboratories or professional service organizations, the technical advisory consultant will recommend several recognized leaders in that field.

Trailer Solves Lubrication Problems



This mobile lubricating-oil reclaimer for use behind the fighting line has been designed, built, and delivered to the United States Marine Corps by the Youngstown Miller Company, Sandusky, Ohio. On the trailer unit is a standard Y-M reclaimer, a Diesel-electric generating set, a clean-oil storage tank, a fuel-oil tank, and waterproof storage bins for refinery earths, filter papers, and spares. In operation, a charging pump conveys the dirty oil from drums on the ground to the heating tank, where, in intimate contact with refinery earth, it is brought to a temperature sufficient to dissipate the volatiles. Then the oil is dropped into a transfer tank and forced through a two-stage filter to clean-oil receiving drums by compressed air

Labor Department Sponsors Industrial Safety Campaign

Under the sponsorship of the Division of Labor Standards of the United States Department of Labor, 550 safety engineers will donate 20 per cent of their time to aiding a national campaign to conserve man power for war production. Any plant management may secure the service of one of these engineers simply by requesting it. After a consultation the safety engineer will analyze the safety training needs of the plant. He will supply information about existing courses in safety training and help enroll qualified workers.

As an additional part of the safety campaign, standard basic courses of 96 hours on principles and techniques of industrial safety have been organized. Located in industrial centers for the convenience of workers these evening classes are offered for two groups: key supervisory employees and members of joint safety committees—both union and management representatives. The Division of Labor Standards prepares training aids: outlines, guides, textual material, references, supplementary pamphlets, and bulletins. The United States Office of Education through its Engineering, Science, and Management War Training Program, pays the costs of the courses and local engineering colleges sponsor them.

OCD Establishes National Security Award. Establishment of a National Security Award recognizing outstanding plant security programs and formation of a national board of review to pass on the protection and security records of plants otherwise eligible for the award, were made recently by the Office of Civilian Defense. Not limited to munition manufacturers, but including manufacturers of essential civilian goods, public utility organizations and other essential establishments, the award will be granted by the OCD for achievement in protection of employees,

physical property, and production processes against air raids, fire, sabotage, accident, and other dangers. The board of review, composed of delegated representatives of seven major labor, management, and safety organizations, is: Percy Bugbee, National Fire Protection Association; P. L. Hardesty, Chamber of Commerce of the United States; R. E. Wilson, National Bureau for Industrial Protection; G. J. Richardson, International Association of Fire Fighters; E. S. Webb, National Safety Council; C. G. Goff, Brotherhood of Locomotive Firemen and Enginemen; and T. M. Brennan, National Association of Manufacturers.

Wider Subcontracting of Orders for Test Equipment Planned

To meet increasing requirements of the armed services for electronic test equipment, a plan for wider subcontracting of orders for critical test equipment, test instruments, and component parts has been initiated by the radio and radar division of the War Production Board. Suggested items for subcontracting include:

1. Those models having a relatively small volume of sales. This releases productive capacity for the large volume models requiring the prime contractor's special skill.
2. A part, or all, of the order for a model having a large backlog.
3. Component parts.

Regional offices of the WPB have been requested to furnish detailed reports on manufacturers and facilities available for prime contracts or subcontracts for this apparatus. At the same time, each manufacturer of electronics test equipment has been asked to indicate which firms would be most capable of adapting themselves to produce, under subcontract, items for his schedule.

Premature Grenade Explosions Prevented. An automatic X-ray machine, which accurately checks the proper amount of powder needed to prevent the grenade's exploding as soon as a soldier releases his grip on the handle has been devised by the General Electric Company at the request of the army. This machine, the first of its kind in the country, will check 4,000 fuses an hour. The metal grenade fuses, slightly larger but similar in appearance to a clinical thermometer, are passed through the machine on a movable belt. The perpendicular beam of a 100,000-volt X ray penetrates each fuse and casts its glow on a fluorescent screen above which is a phototube of "electric eye." Should a fuse with a light powder charge pass over the X-ray beam, the phototube detects the change in the fluorescent glow, rings a bell, flashes a red light, places a dab of red paint on the fuse, and records the "dud" graphically on a meter chart. This four-way check makes it impossible for a defective fuse to pass undetected.

OTHER SOCIETIES

ASCE Adopts Program for Postwar Construction

Despite the fact that the United States now is engaged in total war, a program of both private and public construction projects of immediate and unquestioned usefulness that can be planned now and undertaken after the war is essential if man power now engaged in the war effort is to be absorbed quickly into peacetime pursuits. Such is the basis of a program recently adopted by the board of direction of the American Society of Civil Engineers, for stimulating plans for postwar construction. The program was outlined by the society's committee on postwar construction, under the chairmanship of G. Donald Kennedy. To execute the work of the committee and to enable the society to assist local bodies in the development of such a program, the board approved the appropriation of $15,000 to permit employment of a full-time member of the society's staff.

Basic to the society's program is the fact that the great program of war construction has almost been accomplished, and that soon there will be available a large number of experienced engineers and architects, many of them above military age or incapable of combat duty, whose services could be employed effectively in the preparation of detailed plans and specifications for useful postwar construction projects. Also basic to the society's program are the recommendations that these projects be developed under the existing contract system, and that promptness be exercised in letting contracts immediately after the cessation of hostilities.

Under the leadership of the Committee of Economic Development, industry already is evolving tangible plans for conversion to peacetime production designed to satisfy the accumulated postwar demand for durable and consumer goods. An essential part of this industrial activity will be the alteration or construction of plant facilities. Some plants with greatly expanded facilities will require little adaption; plants of pure war utility may be dismantled; and older facilities that have become obsolete will require modernization or replacement.

An acute demand for new private housing is expected to manifest itself as soon as wartime limitations are lifted. An early start on this housing can be made through stimulation of the advance purchase of sites for individual homes or housing projects, and through the advance completion of plans and specifications.

The successful administration of a public-works program, the ASCE statement says, depends upon the way in which it balances with the other forces of national economy, its readiness to be set in motion in time of emergency, and the nature of the projects it fosters. From past reports it is known that industry and private housing account for approximately two thirds of all construction activities, and that only the remaining third can be devoted to public works if equilibrium is to be maintained. Then, too, it is not enough to catalogue or list the projects under consideration, with approximate estimates of their costs and indications of how they may be financed. The real need is that means be provided for complete preparation *now* of actual plans and specifications and other preliminary work relating to rights of way, means of financing, and the acquisition of property rights. Common sense dictates the selection of projects that will create the proper balance between immediate postwar needs and long-range construction planning.

It is also essential that the public works program, while adding to the wealth of the country, does not involve too severe a tax burden on the people. Most states have laws that permit financing certain types of public improvements on a revenue-bond basis. Such bonds are not a general public tax obligation but an obligation retirable out of the earnings of the projects themselves, derived from payments made by the actual users. Projects coming into this classification include water supply and distribution systems; water purification plants, sewerage systems, and sewerage-disposal plants; public swimming pools; hospitals; large housing projects; public markets; off-street parking facilities; street improvements giving access to private property; express and limited highways, highway tunnels, and toll bridges; and irrigation and drainage projects.

Outstanding bond issues for public improvements which are not of this self-liquidating nature are being paid off during the war period to such an extent that many local political units can incur additional bond indebtedness within legal limitations. These projects include schools; parks and recreational facilities; libraries; buildings for housing local government agencies such as city halls, courthouses, and jails; flood-control projects of local significance; public health centers; state penitentiaries; state hospitals for the insane and feeble-minded; state homes for orphans or the aged; buildings for state universities or other public institutions of higher learning; and public highway and urban street improvements.

Some state and local laws or other similar obstacles may prevent the immediate financing of planning for local public works. Where this is the case it may become necessary for Congress to authorize a revolving fund, and a system of making loans under proper safeguards, as a means of getting such work under way.

As regards federal public works, agencies engaged in various forms of construction for the federal government are already surveying projects which could be undertaken profitably. The ASCE program recommends that appropriations be made now so that these departments may proceed promptly in preparing detailed plans and specifications. Before undertaking these projects, it should be ascertained that they have practical utility and are sound economically, and that they do not compete with facilities provided through private enterprise.

Future Meetings of Other Societies

American Institute of Chemical Engineers. 36th annual meeting, November 15–16, 1943, Pittsburgh, Pa.

American Institute of Mining and Metallurgical Engineers. Annual meeting, February 20–24, 1944, New York, N. Y.

American Society of Heating and Ventilating Engineers. 50th annual meeting, January 31–February 2, 1944, New York, N. Y.

American Society of Mechanical Engineers. Annual meeting, November 29–December 3, 1943, New York, N. Y. Spring meeting, April 3–5, 1944, Birmingham, Ala. Semiannual meeting, June 19–20, 1944, Pittsburgh, Pa.

Engineering Institute of Canada. Annual meeting, February 1–11, 1944, Quebec, Que.

Exposition of Chemical Industries. December 6, 1943, New York, N. Y.

National Fire Protection Association. May 8–11, 1944, Philadelphia, Pa.

Society of Naval Architects and Marine Engineers. 50th anniversary and annual meeting, November 10–13, 1943, New York, N. Y.

Physicists Acquire New Headquarters. As the first step in the program for the development for physics outlined by the war-policy committee of the American Institute of Physics, a new national headquarters' building at 57 East 55th Street, New York, N. Y., has been purchased by that institute. According to present plans, the institute expects to occupy the new headquarters by January 1, 1944. Financing of the project is being accomplished through subscriptions from physicists and others interested in physics. A goal of $75,000 has been set in order to provide the necessary funds for the purchase of the property. Present headquarters of the institute is at 175 Fifth Avenue, New York, N. Y.

HONORS

AIME Awards Three Medals

The awarding of the Charles F. Rand Memorial Medal to Cornelius F. Kelly, chairman of the board, Anaconda Copper Mining Company, Butte, Mont.; the Anthony F. Lucas Gold Medal to Charles V. Millikan, chief petroleum engineer of the Amerada Petroleum Corporation, Tulsa, Okla.; and the William Lawrence Saunders Gold Medal to George B. Harrington, president of the Chicago, Wilmington and Franklin Coal Company, Chicago, Ill., was announced recently by the American Institute of Mining and Metallurgical Engineers.

Mr. Kelley, who received the award for "distinguished achievement in mining administration," has been associated with the copper industry since 1892. After studying law at the University of Michigan, he entered the legal department of the Anaconda Copper company in 1901 and in 1908 became general counsel. In 1911 he was made vice-president and in 1918 became president and director.

The 14th recipient of the Saunders Medal for "distinguished achievement in mining," Mr. Harrington, has been with the Chicago, Wilmington and Franklin company since 1914. He was graduated from Princeton University in 1902 and from the Massachusetts Institute of Technology in 1904.

Mr. Millikan, the sixth recipient of the Lucas Medal for "his outstanding contributions to engineering in the development and production of petroleum," attended the Oklahoma Agricultural and Mechanical College and the University of Pittsburgh. After obtaining experience in the mid-continent and Appalachian oil fields, he joined the Amerada corporation in 1922.

SPEE Awards Lamme Medal to Thomas Ewing French

Thomas Ewing French, professor and head of the department of engineering drawing, Ohio State University, Columbus, is the 16th recipient of the Lamme Medal of the Society for the Promotion of Engineering Education. Professor French is commended for "his genius in teaching the graphical language of engineering; his facility in producing successful textbooks of engineering drawing . . the breadth of his personal culture . . his perennial interest in students . . his guidance of the athletic problems of his University" in the citation accompanying the award.

Professor French, who was born in Mansfield, Ohio, in 1871, graduated from the course in mechanical engineering at Ohio State University in 1895. In 1922 Monmouth College conferred the honorary degree of doctor of science upon him. He was appointed head of the department of engineering drawing at Ohio State University in 1906. Author of many texts and articles on drawing and lettering, he was the first author to substitute the name engineering drawing for mechanical drawing and is a contributor to the *Encyclopedia Britannica*. He is a past president (1927–28) and council member (1916–19) of the SPEE. Professor French is also a fellow of the American Association for the Advancement of Science and a member of the American Society of Mechanical Engineers, the Newcomen Society, Phi Beta Kappa, Sigma Xi, and Tau Beta Pi.

IES Establishes New Award

An award of a gold medal intended to give "recognition to meritorious achievement which has conspicuously furthered the profession, art, or knowledge of illuminating engineering," has been established by the Illuminating Engineering Society. The new medal will not be awarded annually nor, in fact, at any stated interval. It is to be awarded from time to time as it is merited but not more than once a year. Final decision on the presentation rests with the Society's council which will consider the recommendations of a committee on award.

Candidates for the award, either members or nonmembers of the Society, may be nominated at any time by a member or associate member of the IES. The candidate's name and record of achievement must be submitted to a special committee on award. Achievement in the fields of engineering, design, applied illumination, optics, opthalmology, lighting research, education, or administration and management will be considered.

The committee on award will be composed of nine members—two thirds drawn from among the past presidents of the Society and one third from the membership at large.

Kennedy Medal Awarded by Engineering Institute of Canada. The Sir John Kennedy Medal, which is awarded as occasion warrants for outstanding merit in the engineering profession and outstanding contribution to the science of engineering, has been awarded to C. J. Mackenzie, dean of engineering, University of Saskatchewan, Saskatoon, the Engineering Institute of Canada announced recently. Doctor Mackenzie holds the degrees of bachelor of engineering from Dalhousie University and master of civil engineering from Harvard University. He was awarded honorary doctorates by Dalhousie University and McGill University in 1941. He first joined the faculty of Saskatchewan University in 1912 and has been dean since 1921. Active in civil affairs, he has practiced as consulting engineer in western Canada. Since 1939, when he succeeded A. G. L. McNaughton (HM '42) he has been acting president of the National Research Council at Ottawa, Ont., and is a past president of the Engineering Institute of Canada.

INDUSTRY

Consumption of Electric Power Increased in Brazil

Aggregate sales of electric power in Rio de Janeiro, Sao Paulo, and Santos, Brazil, totaled 1,984,000,000 kilowatt-hours in 1942, according to the annual report of the Brazilian Traction Light and Power Company, Ltd., which, through affiliated companies, controls the electricity supply in those areas. This total represents an increase of 8.4 per cent more power than that consumed in 1941, and was distributed among 622,051 customers—30,116 more than in 1941.

The capacity of generating plants rose from 556,509 kw in 1941 to 591,509 kw in 1942, and the total connected load rose from 1,286,890 kw to 1,392,522 kw. Approximately 30 miles were added to the transmission system, making the total length of lines in operation 2,083 miles.

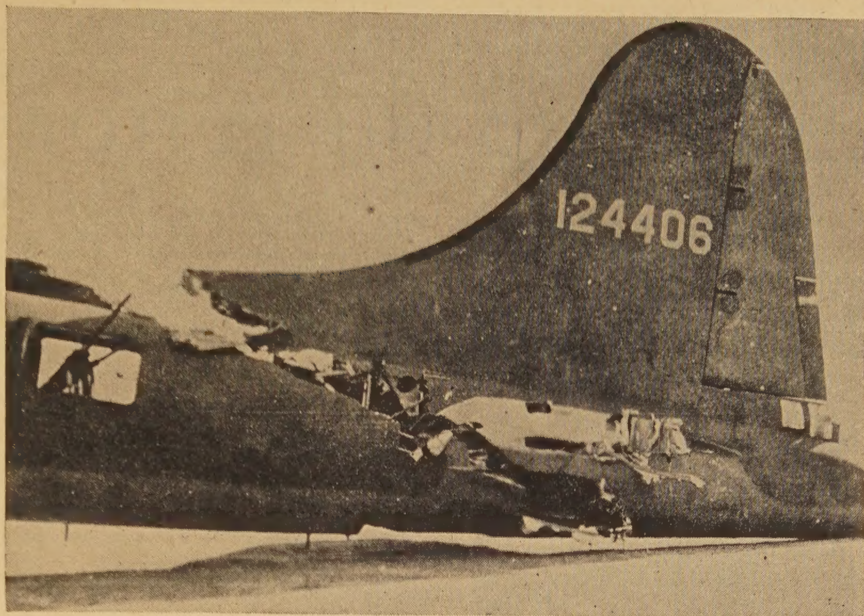
Distribution lines, mostly overhead, measure 32,066 miles.

Vegetable Fuels Used for Part of Argentina's Electric Power

More than one third of the 390,000,000 kilowatt-hours generated by Cia. Italo-Argentina de Electricidad of Buenos Aires, Argentina, in 1942 was produced by using vegetable fuels, according to the foreign press. During the year, two boilers at the New Port station were altered so that pulverized cereals could be used for fuel, and two others were converted to burn corn. Vegetable fuels were used also in the Pedro Mendoza station. In both instances it was necessary to install special handling, storage, and pulverizing equipment to take care of the new type of fuel.

Exposition of Chemical Industries to Be Held in New York. The 19th Exposition of Chemical Industries will be held in Madison Square Garden, New York, N. Y., during the first week in December 1943, with admission by invitation, and registration only for executives, chemists, chemical engineers, plant managers, and staff personnel directly associated with industries having a chemical interest. A significant exhibit will be one sponsored by the Alien Property Custodian of the United States Government of the complete library of former enemy-controlled patents, now available for use under license by American manufacturers in chemical, electrical, and mechanical fields. In addition to issuing patent licenses, the Office of the Custodian soon will begin to sell to American investors enemy-owned businesses worth billions of dollars. The properties to be transferred range from the multimillion dollar Aniline and Film Corporation to delicatessens and cobblers' shops. Inventories of these properties will be made available by the Custodian's office.

Automatic Pilot Improves Precision Bombing



The supersensitivity of the electronically controlled automatic pilot, developed by Minneapolis-Honeywell Regulator Company and used on all United States Army bombers since 1941, holds a plane to its course despite cross currents, wind variation, and blast from exploding antiaircraft shells. Besides supplying a steady platform for high-altitude precision bombing, the device permits of variable installation, so that the plane can be flown from two or three different points. Although the manual control cables connecting to the rudder and elevators were severed in a mid-air collision with a German Messerschmitt, this Boeing Flying Fortress was flown safely home on the autopilot because the control circuit motors of the electronic system were located far in the tail and were not damaged in the crash

JOINT ACTIVITIES

New Standard for Graphs Issued

Recommendations, intended to result in more legible and understandable graphs, based on past practice or on scientifically established principles are made to authors of technical material by the new "American Standard for Engineering and Scientific Graphs for Publications," recently issued by the American Standards Association.

Besides presenting well-grounded reasons for the rules and guides formulated, helpful illustrations and examples are provided. Starting from the standpoint of the function a graph should fulfill and emphasizing the distinction between graphs which will reproduce well and those which may be best for other display or demonstration purposes, the standard reaches the conclusions that: a graph should complement not duplicate textual material; exaggerated sizes or lines which distract from the text should be avoided; consideration must be given to the optics of lettering (numerical ratios are given); and disproportionate enlarging of any one factor in a graph should be avoided. Other pitfalls, obvious to the printer but not always to an author, are pointed out. Copies may be obtained from the American Standards Association, 29 West 39th Street, New York 18, N. Y., at 75 cents per copy.

EDUCATION . . .

Northwestern Forms Advisory Committee

Eleven representatives of business, industry, and technical education comprise the new advisory committee on the development of the Technological Institute of Northwestern University, President Franklyn B. Snyder announced.

Charles F. Kettering (F '14) vice-president of General Motors Corporation, Dayton, Ohio, who was selected as adviser to the Technological Institute by its founder, Walter P. Murphy, in 1939, is committee chairman.

From the field of technical education the four committee members are: K. T. Compton (F '31), Massachusetts Institute of Technology, Cambridge; R. A. Millikan (HM '33), California Institute of Technology, Pasadena; W. E. Wickenden (F '39), Case School of Applied Science, Cleveland, Ohio; and R. E. Doherty (F '39), Carnegie Institute of Technology, Pittsburgh, Pa. The remaining six members from business and industry are: Henry J. Kaiser, shipbuilder and industrialist; Juan Terry Trippe, president of Pan American Airways; James S. Knowlson, president of Stewart Warner Corporation; General Robert E. Wood, chairman of the board, Sears Roebuck and Company; Ralph Budd, president of the Burlington Railroad; and Paul E. Klopstag, president of the Central Scientific Company.

The new committee will be concerned primarily with the postwar program and activities of the institute. It will counsel the institute on its relations with industry, future theoretical and applied research programs, curricula in engineering and

science, new techniques in engineering education, and engineering prospects in the United States and abroad. For further details about the Technological Institute see the July 1942 issue of *Electrical Engineering*, page 385.

high-pass, and confluent band-pass filters are eliminated. For the low- and high-pass filters, the two arms are resonant at the cutoff frequencies, and the impedance of either at the cutoff frequency is equal to the load resistance of the filter. The transformation of the frequency that changes the low-pass filter into the confluent band-pass filter preserves this relationship.

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C. R. BURROWS (M '33)

(Radio research engineering department, Bell Telephone Laboratories, Inc., New York, N. Y.)

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Current-Transformer Excitation Under Transient Conditions

To the Editor:

I wish to thank Mr. Etches for making available the corrections to our paper, "Current-Transformer Excitation Under Transient Conditions," by D. E. Marshall and P. O. Langguth, published in AIEE *Transactions*, volume 48, October 1929, pages 1464–74. We have checked the *Transactions* copy of the original paper and find the errors to be as pointed out and the corrected equations as given by Mr. Etches to be correct. (*EE, May '43, p. 228*).

In the interests of complete accuracy, we wish to point out that the symbol T as used in the corrections appears in two kinds of type. This is not mathematically significant.

D. E. MARSHALL (M '33)

(Sections engineer, electronics engineering department, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.)

Deriving the Parameters of Filters

To the Editor:

It is very disappointing to have such authorities as Schelkunoff,[1] Slater,[2] and Terman[3] publish the well-written books they recently have and still base their derivation of the parameters of the ladder-type filter on the full section as done by Campbell,[4] the inventor of this type of filter, when the half section is so superior pedagogically.

Consider the network shown in Figure 1. Here Z is the impedance of the series

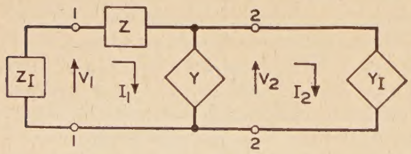

Figure 1

branch and Y the admittance of the shunt branch of the half section. Z_I and Y_I are the mid-series image impedance and mid-shunt image admittances, respectively. Then the impedance of the network looking to the right at 1–1 is

$$Z_I = Z + \frac{1}{Y + Y_I} \qquad (1)$$

and the admittance of the network looking to the left at 2–2 is

$$Y_I = Y + \frac{1}{Z + Z_I} \qquad (2)$$

Substituting the value of Y_I from equation 2 in equation 1 gives the mid-series image impedance

$$Z_I = \sqrt{\frac{Z}{Y}}\sqrt{YZ+1} \qquad (3)$$

Substituting the value of Z_I from equation 1 in equation 2 gives the mid-shunt image admittance

$$Y_I = \sqrt{\frac{Y}{Z}}\sqrt{YZ+1} \qquad (4)$$

The latter also may be written directly from symmetry.

These expressions are simpler to derive and remember than the usual expressions, namely,[5]

$$Z_{I1}(=Z_I) = \sqrt{Z_1 Z_2 + Z_1^2/4} \qquad (5)$$

and

$$Z_{I2}\left(=\frac{1}{Y_I}\right) = \sqrt{\frac{Z_1 Z_2}{1+Z_1/4Z_2}} \qquad (6)$$

Also the expression for the image-transfer constant, θ, is simpler for the half section or L section

$$\sinh \theta = \sqrt{ZY}$$

than the older expression for the II or T section[6]

$$\sinh \theta_{w/2} = \sqrt{Z_1/4Z_2}$$

If the development is based on the L section, the II and T sections follow directly by putting two L sections back to back. But by using the L section the factors of two and one half which occur in the design equations for the simple low-pass,

Electrical Engineering in the War

To the Editor:

Have been over here for about a year now, with the Army Engineer Corps, and it has been a busy year, as you know. Modern warfare is about half engineering, of one kind or another, and we get all kinds and then some.

Electrical engineers are well represented over here but it seems to me the Army needs about twice as many electrical engineers and trained electricians as it now has.

Now that the preliminary African "bout" is over we will have to get ready for the "main event." We will need all the electrical equipment that American electrical manufacturers can produce, and they sure are producing some beautiful stuff. It has to meet tough conditions—and it does.

Maybe we will get it down some day to where you just push a button—and Bingo—another big hole in the map!

A LIEUTENANT COLONEL, UNITED STATES ARMY

24-Hour Time Designation

To the Editor:

I should like to second Mr. Sidney Withington's proposal for a 24-hour time designation in this country. Naturally, those who have utilized that system in Europe can better appreciate its advantages than those who have not had an opportunity to try it. Since the latter constitute the great majority, considerable effort un-

doubtedly will be required to overcome their "conservatism."

In this case, the "conservatism" probably should be classified as mental rather than economic and so not of "the same kind which has inhibited adoption of the metric system of weights and measures . . . ." As I recall it, a very comprehensive investigation a few years ago indicated it would be decidedly uneconomic to change our machine tools from English to metric units. Perhaps that change might be reconsidered after the war.

I am interested also in another time-designation proposal which does not conflict in any way with Mr. Withington's. In 1936, and again in 1942, I proposed over the radio that the proper standard-time designation be substituted for the daylight-saving-time designation utilized in each standard time zone during the "fast-time" period. Thus, the term "eastern standard time" would be substituted for "central daylight-saving time" in the central time zone. In our eastern time zone, the term "Atlantic standard time" would be substituted for "eastern daylight-saving time."

This proposal usually appeals to scientifically minded individuals who understand the advantages of using well-standardized terms whenever possible. However, these advantages are not so apparent to the majority. Also, to them "Atlantic standard time undoubtedly is as unfamiliar as "24-hour time." Thus, unfamiliarity with one of the proposed terms, "conservatism" or mental inertia, lack of suitable promotion, and now the war, have prevented so far the adoption of the standard-time designations.

I hope Mr. Withington will be more successful with his proposal.

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NEW BOOKS • • •

The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.

History of the Latin-American Nations. By W. S. Robertson. Third edition. D. Appleton-Century Company, Inc., New York, N. Y.; and London, England, 1943. 560 pages, $6^1/_2$ by $9^1/_2$ inches, $4.

Written for the general reader as well as for college and university classes, this history attempts to satisfy the growing interest of both groups in the countries of South and Central America and Mexico. In his presentation the author stresses the differences which give individuality to the political units composing Latin America. Separate treatment is accorded each country's struggle for independence and its subsequent history. However their common source in 15th century Spanish civilization and the prehistoric Indian civilizations is given consideration. Colonial culture and institutions are surveyed. In the discussion of the modern governments emphasis is laid on political and constitutional changes. The field of Latin America's relations with Great Britain, other European powers, and the United States, of which the author has made a special study, also is covered. Chapter references have been added to the present edition, and maps have been provided where necessary.

Reference Data for Radio Engineers. Federal Telephone and Radio Corporation, 67 Broad Street, New York, N. Y., 1943. 200 pages, $5^3/_4$ by $8^3/_4$ inches, $1; orders of 12 or more, 75 cents per copy.

This radio reference handbook is an attempt to provide for the requirements of the engineer as well as the radio technician. Compactly presenting more of the fundamentals of radio than are offered by the usual handbook, it should be useful both in the laboratory and the field. The material is compiled under the following general headings: general engineering tables, engineering and material data, audio and radio design, rectifiers, vacuum tubes and amplifiers, telephone transmission, radio-frequency transmission lines, radio propagation and antennas, noise and noise measurement, nonsinusoidal wave forms. There are also sections of mathematical formulas and tables.

Machine Shop Yearbook and Production Engineers' Manual. 2nd edition. Edited by H. C. Town. Paul Elek, Africa House, Kingsway, London, W.C.2, England, 1943. 497 pages, illustrations, etc., $8^1/_2$ by $5^1/_2$ inches, cloth, 30s. 10d., or abroad 31s. 6d. (ESL.)

Late developments in production, management, and design are here presented in convenient form for reference and study. Four special articles are included: on electrical-control gear for machine tools, on optical instruments in engineering, on centerless grinding, and on the direct hydraulic system. Machine-tool construction and operation are discussed at length, with descriptions of representative British machine tools. The periodical literature of 1942 is represented by abridged articles of important publications on production and shopwork.

Formulas for Stress and Strain. By R. J. Roark. 2nd edition. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. 366 pages, diagrams, etc., 9 by 6 inches, cloth, $4. (ESL.)

Intended as a reference book for designers, this book offers a compact summary of the formulas, facts, and principles relating to strength of materials. Part 1 treats of definitions and symbols. Part 2 states general principles and describes methods of stress analysis and the behavior of material under stress. Part 3, which occupies most of the book, discusses the behavior of structural elements under various conditions of loading and gives extensive tables of formulas for the calculation of stress, strain, and strength. Bibliographies accompany the chapters. The new edition has been enlarged.

Manual of Firemanship, Part I. Great Britain, Home Office (Fire Service Department). His Majesty's Stationery Office, London, England, 1943. 250 pages, illustrations, etc., $8^1/_2$ by $5^1/_2$ inches, paper, 2s. 6d. (obtainable from British Information Services, 30 Rockefeller Plaza, New York, N. Y., 75 cents). (ESL.)

This book is the first section of a proposed seven-part work which is intended to be a comprehensive textbook and reference work for fire fighters. The present installment discusses the theory of fire fighting and the equipment. The theory of combustion, methods of extinguishing fires, hose, hose fittings, ladders, ropes, hand pumps, chemical extinguishers and foams, and apparatus for breathing and resuscitation are discussed. Much practical information is given.

Theory and Practice of Heat Engines. By H. R. Grundy. Longmans, Green and Company, London, England; New York, N. Y.; and Toronto, Ont.; 1942. 723 pages, illustrations, etc., 9 by $5^1/_2$ inches, cloth, $6.25. (ESL.)

This textbook offers a course covering steam generators, reciprocating steam engines, steam turbines, and internal-combustion engines in one volume. It is intended to cover the practical side of the subject and the accompanying theory to a stage from which an easy step may be made to more specialized books. The book is profusely illustrated with drawings, and the text is clear and readable. Considerable attention is given to historical development. A good picture of modern practice, especially British, is provided.

Drying and Dehydration of Foods. By H. W. von Loesecke. Reinhold Publishing Corporation, New York, N. Y., 1943. 302 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, $4.25. (ESL.)

This book, which aims to offer a compilation of the latest practical information on its subject, is the work of one who has had considerable experience in research work on dehydration. It presents a general outline of procedures and practices in commercial use. Types of dehydrators, the dehydration of various classes of foods, plant sanitation, costs, the nutritive value of dried foods, packing, storage, methods of analysis, and the reconstitution of dehydrated foods are considered. A glossary and a list of patents are apprended.

Radio Engineers' Handbook. By F. E. Terman. McGraw-Hill Book Company,

Inc., New York, N. Y., and London, England, 1943. 1019 pages, illustrations, etc., 9 by 6 inches, leather, $6. (ESL.)

This handbook brings together, in form for reference use, the body of engineering knowledge that is the basis of radio and electronics. It presents, in organized form, the more important contributions to the art that have appeared in the technical articles, over 2,000 in number, that were reviewed in preparing it. Extensive references provide access to much pertinent literature. As the book is essentially a one-man job, the viewpoint is consistent throughout and gaps and duplications are avoided.

Engineering Mechanics. By F. L. Singer. Harper and Brothers, New York, N. Y., and London, England, 1943. 482 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $4. (ESL.)

This is a textbook that aims to present the fundamentals of the subject in a manner that will result in thorough understanding and permanent possession of them. Toward this aim, emphasis is centered on a physical understanding of the basic operations, rather than on routine rules. Equations are interpreted in terms of their geometrical equivalents, wherever possible. Analytic methods have been emphasized without neglecting graphic ones. Numerous illustrative problems are explained to show the applications of the theory.

Engineer's Manual of English. By W. O. Sypherd, A. M. Fountain and S. Brown. Revised edition. Scott, Foresman and Company, Chicago, Ill.; Atlanta, Ga.; Dallas, Tex.; New York, N. Y.; 1943. 503 pages, diagrams, etc., 8 by 5 inches, cloth, $2.50. (ESL.)

This compact volume is intended as a textbook in English composition for students and as a reference book on usage for engineers. After the technique that underlies all good writing has been presented, the writing of letters, reports, articles, bulletins, and specifications is discussed in detail with numerous examples. The new edition has been revised thoroughly and much improved. It will be found useful by all readers.

Metals and Alloys Data Book. By S. L. Hoyt. Reinhold Publishing Corporation, New York, N. Y., 1943. 334 pages, illustrations, etc., $10^1/_2$ by 7 inches, cloth, $4.75. (ESL.)

Mr. Hoyt has performed a task of great value, and the result will be most useful to metallurgists and engineers. It contains in compact usable form, carefully selected values for the physical and engineering properties of the metals and alloys of commercial importance. The wrought, cast, and stainless steels, cast irons, heat-resistant and corrosion-resistant casting alloys and nonferrous alloys are covered in detail. The data are chiefly presented in tables with brief comment.

Physics of Metals. By F. Seitz. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. 330 pages, diagrams, etc., $8^1/_2$ by $5^1/_2$ inches, fabrikoid, $4. (ESL.)

This work is based on an evening lecture course given to practicing metallurgists with a limited knowledge of physics. The treatment is entirely nonmathematical. The developments of recent years are discussed, including the structure of metals, the factors that determine the stability of alloys, the theory of plasticity in metals, diffusion in metals, the theory of iron–carbon alloys, and the electron theory of solids and its applications to cohesion, magnetism, and conductivity.

Introduction to Circuit Analysis. By A. R. Knight and G. H. Fett. Harper and Brothers, New York, N. Y., and London, England, 1943. 447 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $4. (ESL.)

This book is intended as a text for the initial and basic course in electrical engineering. The first five chapters provide an understanding of the necessary fundamental electrical and magnetic laws, and serve as a review of previous study. Chapter 6 is a detailed study of the step-by-step solution of electric circuits. Succeeding chapters develop the electric-circuit theory and include a discussion of electric-transient theory from the physical point of view.

Rewinding Data for Direct-Current Armatures. By G. A. Van Brunt and A. C. Roe. 2nd edition. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. 277 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, $2.50. (ESL.)

Detailed practical directions are given for rewinding all types of these armatures and for taking and recording the necessary data. The new edition has been revised and enlarged. New data include such recent developments as the use of glass fiber insulation, drying and baking by infrared heating, and the introduction of new insulating varnishes.

Aircraft Navigation. Part I: Theory, by H. Stewart and A. Nichols. Part II: Practice, by S. A. Walling and J. C. Hill. Macmillan Company, New York, N. Y.; University Press, Cambridge, England, 1943. 146 pages, illustrations, etc., $8^1/_2$ by $5^1/_2$ inches, cloth, $2. (ESL.)

Beginning students of air navigation will find here a concise introduction to the subjects that they must master. Star identification, map reading, position finding, meteorology, and other theoretical matters are explained, and a large number of practical problems provided. The text is the work of British authorities, but has been revised for American use.

Handbook of Plastics. By H. R. Simonds and C. Ellis, assisted by M. H. Bigelow. D. Van Nostrand Company, New York, N. Y., 1943. 1082 pages, illustrations, etc., $9^1/_2$ by $6^1/_2$ inches, cloth, $10. (ESL.)

This volume aims to meet a desire for a comprehensive reference work that would treat the details of the subject in one volume. It presents, in nine sections, the fundamental basis and technology of the plastics industry, including the physical and chemical properties of plastics, their production, manufacture, finishing, and applications. A section on plant practice is included. There is a list of trade-marks and trade names, and a bibliography.

Physical Chemistry. By F. H. MacDougall. Revised edition. The Macmillan Company, New York, N. Y., 1943. 722 pages, diagrams, etc., 9 by $5^1/_2$ inches, cloth, $4.25. (ESL.)

This is an introductory text which aims to provide a sound working knowledge of the subject for students of chemistry and chemical engineering. The new edition has been revised to include changes in the accepted value of fundamental constants and certain additions to the text.

PAMPHLETS • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Community Action for Post-War Jobs and Profits. United States Department of Commerce, Washington, D. C., copies sent on request.

War Winning Suggestions in the War Production Drive. War Production Board, Washington, D. C., 61 pages.

Cooling System: Cleaning, Flushing, Rust Preventions, and Antifreeze. Prepared by the Society of Automotive Engineers, Inc., Office of Defense Transportation, 1147 New Post Office Building, Washington, D. C., 25 pages.

Bridgeport Condenser Tube Manual. Bridgeport Brass Company, Bridgeport 2, Conn., 112 pages.

Trail Blazer to Radionics and Reference Guide to Ultrahigh Frequencies. By E. Kelsey, Zenith Radio Corporation, 680 North Michigan Avenue, Chicago 11, Ill., 56 pages, no charge, copies available upon requests for use in schools.

Recreation—a Resource of War. The Division of Recreation, Federal Security Agency, Social Security Building, Washington 25, D. C., 8 pages, no charge.

Products and Priorities. Issued every four weeks by the War Production Board, Washington, D. C., 13-week subscription, $2.

List of Inspected Appliances Relating to Accident Hazard, Automotive Equipment, Burglary Protection. Underwriters Laboratories, Inc., 161 Sixth Avenue, New York 13, N. Y., 77 pages.

Electricity in the Chemical Industry. General Electric Company, Schenectady, N. Y., 40 pages.

Economical and Permanent Construction with Pressure-Treated Wood. Koppers Company, Wood Preserving Division, Pittsburgh, Pa., 26 pages, no charge.